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AGRICULTURAL EXPERIMENT STATION

OF THE

COLLEGE OF AGRICULTURE AND
MECHANIC ARTS

WEST RALEIGH

SOME INSECT ENEMIES OF GARDEN CROPS

N. C. COLLEGE OF AGRICULTURE AND MECHANIC ARTS

THE NORTH CAROLINA
AGRICULTURAL EXPERIMENT STATION

UNDER THE CONTROL OF THE

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TABLE OF CONTENTS

PAGE

Angoumois grain moth—*illustrated*.. 39

Aphis, cabbage 17

Arsenate of lead, preparation of..... 61

Arsenical poisons, names and formulas 60

Asparagus beetle, the common—*illustrated* 9

Asparagus beetle, the 12-spotted—*illustrated* 9

Bean, insects of..... 11-15
cutworms injurious to—*illustrated* 11
leaf beetle—*illustrated* 14
weevils—*illustrated* 15
wireworms injurious to..... 11

Beet, insects of..... 16, 17
cutworms injurious to..... 16
flea-beetles injurious to..... 16
leaf miner 16
webworms injurious to—*illustrated* 16
wireworms injurious to..... 16

Biting insects, general description... 8

Bordeaux mixture 61
and arsenicals 61

Cabbage, insects of..... 17-29
aphis—*illustrated* 17
cutworms injurious to..... 17
flea-beetles on..... 17
looper—*illustrated* 26
maggots—*illustrated* 28
plutella (diamond back moth).. 27
snake—*illustrated* 29
terrapin bugs on—*illustrated*.... 18
webworm—*illustrated* 23
worm (imported)—*illustrated*... 20
worm (native)—*illustrated*..... 22

Cantaloupe, insects of..... 40-46
cutworms, injurious to..... 40
cucumber flea-beetle on—*illustrated* 44
melon louse—*illustrated* 40
pickle worm on—*illustrated* 44
red spider on..... 40
striped cucumber beetles on—*illustrated* 42

Carbolic acid emulsion for root maggots 47

Carbon bi-sulphid, uses of..... 39, 48

PAGE

Cauliflower, insects of (*See cabbage*), 17

Celery, insects of..... 30
caterpillar 30
cutworms injurious to..... 30
lice on 31
red spider injurious to..... 31

Chewing or biting insects..... 8

Collard, insects of (*See cabbage*), 17-29

Colorado potato beetle—*illustrated*... 49

Common names of young insects..... 7

Corn, insects of..... 31-40
ear worm—*illustrated* 37
root-worm or bud worm—*illustrated* 33
stalk borer—*illustrated* 35
weevils—*illustrated* 39
wireworms injurious to—*illustrated* 31

Cucumber, insects of (*See cantaloupe*) 40-46

Cutworms, life history, habits and remedies—*illustrated* 11

Egg plant, insects affecting..... 46, 47

Feeding habits of insects..... 8

Fertilizer, for root maggots..... 28

Flea-beetle, the cucumber—*illustrated* 44

Formulas for preparing spray mixtures—
for biting insects..... 60-62
for sucking insects..... 63, 64

Fumigation for melon louse..... 41

Growth of insects..... 6, 7

Grubs, definition of..... 7, 52

Grub worms, or white grubs—*illustrated* 52-54

Harlequin or terrapin bug—*illustrated* 18

Hellebore, use of..... 62

Horn worm on tomatoes—*illustrated*, 59

Insects injurious to
asparagus 9-11
beans 11-16
beets 16, 17
cabbage, collard and cauliflower 17-29
celery 30, 31

PAGE

Insects injurious to (*continued*)
cantaloupes and cucumbers... 40-46
egg plant 46, 47
irish potatoes (*See potato*).. 49-54
onion 47
peas 47-49
squash 54-58
sweet corn (*See corn*)..... 31-40
turnips (*See cabbage*)..... 17-29

Kerosene emulsion, preparation of... 63

Kerosene emulsion, use of, 18, 19, 22, 41, 55

Larva, definition of..... 8

Life history of insects, in general.. 6, 7

Lime, uses of..... 43, 60, 61

Maggots, definition of..... 7, 28
affecting cabbage—*illustrated*... 28
affecting onions 47

Melon plant lice—*illustrated*..... 40

Melon borer—*illustrated*..... 57

Nymph, definition of..... 8

Onion, insects of..... 47

Parasites of cabbage aphis..... 18

Parasites of melon aphis..... 42

Paris green, uses of..... 60

Pea weevils—*illustrated*..... 47

Pickle worm of cantaloupe, etc.—*illustrated* 44

Poisoned bait for cutworms..... 14

Potato (irish), insects of..... 49-54
Colorado potato beetle—*illustrated* 49
3-lined potato beetle..... 51
flea-beetles on 51
stalk borer—*illustrated* 51
white grubs injurious to—*illustrated* 53

PAGE

Pupa, definition of..... 7

Pyrethrum, uses of..... 64

Red spider 31, 40

Resin wash and arsenicals..... 62

Soap solutions, as insecticides..... 63

Spray mixtures, formulas..... 60-64

Spray pumps and equipment..... 64

Squash, insects of..... 54-58
bug—*illustrated* 54
melon borer on—*illustrated*..... 57
vine borer—*illustrated* 55

Striped cucumber beetle—*illustrated*. 42

Sweet corn, insects of (*See corn*).. 31-40

Sucking insects 8

Sulphur, uses of..... 31

Terrapin bug—*illustrated*..... 18

Tobacco, uses of..... 18, 43, 63
dust as a repellent..... 63
fumigating papers 64

Tomato, insects affecting..... 58, 59
fruit worm 58
horn worm—*illustrated* 59

Trap plants, uses of.....19, 22, 38, 43, 46, 55

Weevils in beans—*illustrated*..... 15
corn—*illustrated* 39
peas—*illustrated* 47

Whale oil soap, uses of..... 63

Webworm, the cabbage—*illustrated*.. 23

White grubs—*illustrated* 52

Wireworms—*illustrated* 31

SOME INSECT ENEMIES OF GARDEN CROPS

CONTAINING PRACTICAL INFORMATION CONCERNING THE HABITS AND LIFE HISTORIES OF CERTAIN INSECTS, WITH REMEDIAL SUGGESTIONS

By R. I. SMITH, Entomologist

Without the home garden the farm is incomplete. Even the town or city home with its small area of land should possess a garden in which many vegetables may be grown to help supply the table, and reduce the market and grocery bills during both summer and winter. It often happens that the pleasure and profit derivable from the possession of a garden are both greatly diminished by the insects that prey upon the various vegetables, and sometimes entirely destroy them. Far too many gardens are carefully prepared and planted and afterwards allowed to become food for various insects, mainly through ignorance on the part of the gardener of the methods by which they might be controlled. For the person who aims to sell a part of his garden products a knowledge of insects and their control is especially necessary. The question of profit or loss may depend on the suppression or non-suppression of these pests.

It is only too true that some insects are difficult or almost impossible to suppress, but the great majority are within man's control when the proper remedial and preventive measures are applied. An illustration of well known and fairly easily preventable insect injury, occurring annually, is that of the Colorado Potato Beetle, which is perhaps one of the most common. The writer has frequently met with farmers, and small garden owners, who relied solely upon hand picking for the suppression of potato beetles, and frequently even this unsatisfactory method was delayed until the plants were nearly destroyed. How much time, labor, and expense, to say nothing of actual loss, such people might have saved by dusting the potato plants with dry Paris-green mixture, or by using the same poison as a liquid spray. This method of fighting the potato beetle and similar simple, reliable remedies for other insects are discussed in subsequent pages.

Numerous illustrations are inserted to assist the reader in recognizing the insects mentioned and as an aid in understanding their life history and habits. Without some knowledge of these facts insects can not generally be fought intelligently.

In these pages no attempt has been made to include all the various insect enemies of the crops mentioned, but such only as may appear every year and cause more or less damage unless fought successfully. *"To be forewarned is to be forearmed,"* should be the maxim of every gardener. A knowledge of the life history and habits of insects aids one in adopting more successful preventive measures against these enemies.

Life History and Development of Insects.

The habits of insects constitutes a very interesting and broad field for study and investigation. Without some knowledge of the development, i. e., the life history of our principal injurious insects, we would be poorly equipped to conduct a warfare against them. It is not to be expected, nor is it necessary, that every gardener should know all about the changes undergone by these interesting insects, but there are a few principles governing their growth and habits that every person may readily remember. One of these is the *development,* or the changes that an insect undergoes during its life, and another is the *feeding habits* of all the various forms. These two principles, it will be found, are closely related, for certain insects, while in the young, immature stage, secure food by biting and chewing, like caterpillars; while the adult or parent of the same insect may take its food in an entirely different manner, for example, moths and butterflies. Grasshoppers, on the other hand, *always* chew their food, and in order to illustrate two forms of Insect Development, we will compare their growth with that of the Green Cabbage Worm.

Incomplete Metamorphosis.—Grasshoppers undergo incomplete

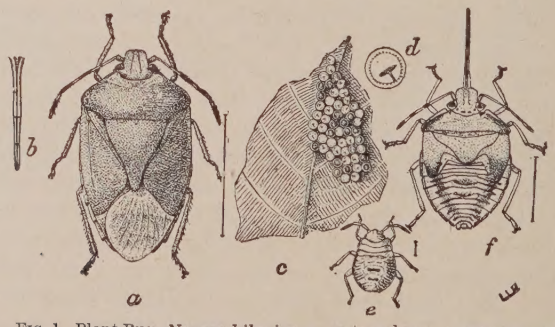

Fig. 1—Plant Bug, *Nezara hilaris: a*, mature bug; *c*, egg mass; *e*, young nymph; *f*, last stage of nymph—enlarged. (Chittenden, Farmers' Bul. 223, U. S. Dept. of Agr.)

metamorphosis or *direct development,* as there are only three distinct stages of growth, namely, *Egg, Nymph* (young), and *Adult.* Grasshopper eggs are deposited in masses in the ground, and from them, in due time, minute grasshoppers hatch, resembling the adult in

general shape but somewhat clumsy in appearance and lacking wings. As they increase in size by successive molts, the wings commence to develop, first appearing as small, blunt pads, and finally becoming full grown. During this development the grasshopper always retains its general form and appearance. That is, a young grasshopper may always be recognized as such. Fig. 1 illustrates the similar growth of a plant bug *(Nezara hilaris)*, a sucking insect that sometimes punctures and injures cotton bolls.

Complete Metamorphosis.—Cabbage worms have a markedly different life history from the grasshopper, as they pass through four distinct stages, namely, *Egg, Larva* (worm), *Pupa* (quiescent stage) and *Adult.* This is called "complete metamorphosis" or *Indirect Development.* The adult or parent of the cabbage worm is a conspicuous white-winged butterfly (See p. 21) that flies about collard and cabbage fields on any bright, warm day. These deposit eggs that hatch into minute worms, which, when grown, change to pupæ corresponding to the familiar cocoon stage of many butterflies and moths. From the pupæ the perfect, fully developed butterflies emerge. To one wholly ignorant of the growth of insects these wonderful changes might seem impossible, but the statement may easily be verified by any one caring to make the experiment. The four stages of the Bean-leaf beetle showing "complete metamorphosis" are illustrated in Fig. 6, p. 15.

A few common garden insects have direct development, the young resembling the adult, such as plant lice, terrapin bugs, squash bugs, plant bugs and grasshoppers, but by far the great majority of them have indirect development, passing from the worm, grub, or caterpillar stage, to entirely different looking forms, such as beetles, moths and butterflies. These complete changes in appearance have at times given people erroneous and ridiculous ideas about certain insects. As an example, the writer once received a letter from a farmer, stating that the plant lice had been very abundant on his cantaloupes, but that they were then changing to beetles. These proved to be lady-bird beetles, predaceous parasites feeding on the lice, and of course an entirely different kind of insect. Besides, the beetles were directly responsible for the disappearance of the injurious lice.

Common Names of Immature Insects.

Entomologists classify insects into various orders, and have adopted a few common, accepted names for the young or immature stage of certain orders. For example, *Maggots* develop into two-winged flies (Order: Diptera); *Grubs* into hard-winged beetles (Order: Coleoptera); *Caterpillars* (both smooth and hairy) into moths or butterflies (Order: Lepidoptera). These common titles are frequently made use

of by writers. Thus the reader may understand that when white grubs are mentioned it refers to the young of some beetles, generally May or June beetles. Similarly when caterpillars are mentioned the term always refers, or should refer, to the larval stage of moths or butterflies.

The term *larva* (plural spelled larvæ) may be used in referring to the young stage of all insects that have complete metamorphosis, such as beetles, bees, flies, moths, etc. The word *nymph* is used for the young of grasshoppers, terrapin bugs, squash bugs, etc., that resemble the adult insects.

Chewing and Sucking Insects.

More important in some respects than the knowledge of the life history of an insect, is that of its feeding habits. Every gardener should understand how insects get their food, whether by chewing or sucking, for without that knowledge he can not as readily understand why certain remedies are suggested against different insects. As already mentioned, the caterpillars, represented by cut-worms and cabbage worms, feed by chewing and actually devouring some portion of the host plant, while the parent moths or butterflies feed entirely differently. All beetles and their young feed by chewing. On the other hand, all plant lice, squash bugs, and most insects commonly known as "bugs," feed by means of long, slender beaks, which are used to pierce the plant tissue, and through which the plant juice is extracted.

Insects, therefore, may be divided into two great classes: first, *Chewing* or *Biting Insects*, and, second, *Sucking Insects*. The former includes all insects, whether in the immature or adult stage, that feed by biting and chewing; the latter includes a large class of insects that feed only by sucking the plant juices. A moment's thought will reveal the reason why it is that a poison spray, such as Paris-green mixture, that acts as an internal poison when swallowed with the food, would not kill an insect that sucks the sap. The latter make only a minute hole with the pointed beak and suck the sap from beneath the surface. How, then, may sucking insects be killed? Naturally by some substance that will kill by contact, having a corrosive, caustic, or suffocating effect. Kerosene emulsion, soap solutions, etc., are examples and are described more fully on pages 63 and 64.

This brief, simple statement of facts is inserted mainly as a suggestion to those readers who desire to learn something about insects. Of course arsenical poison sprays and contact sprays are useless against some insects. Borers and other forms that feed in protected places, even though they chew their food, can not be reached with

arsenicals, neither can sucking insects be killed by a contact spray unless touched by the mixture. It is customary for people to think that all garden insects may be killed by a spray of some description, but this is an erroneous idea. White grubs in the soil feeding on the roots, boring insects hatching from eggs laid under the skin of plants, leaf-mining insects working between the two surfaces of a leaf, and others, can not readily be killed by any spray mixture. For these and various reasons it is necessary to understand the life history of insects; then the weakest, most vulnerable period in their career must be selected as the proper time to effect their eradication or suppression.

Nearly all insects succumb to poison fumes like carbon bi-sulphide and hydrocyanic acid gas, and insects in stored grains are best controlled by the fumigation method. With certain garden insects, cultural methods may be the only successful means of fighting them, and at times two or three methods may be combined against a single species.

INSECTS AFFECTING ASPARAGUS

Fortunately there are not many insects injurious to this valuable plant. There are, however, two asparagus beetles, both imported species, that may do considerable damage. Their injury is due to both adults and larvæ feeding on the young, tender, marketable shoots, rendering them unfit for sale, and also to defoliation of older plants. Since their habits and method of injury to asparagus are much the same they will be mentioned here together.

Common Asparagus Beetle *(Crioceris asparagi,* Linn.).
The 12-spotted Asparagus Beetle *(Crioceris 12-punctata,* Linn.).

DESCRIPTION AND LIFE HISTORY.

Beetles.—Are about one-fourth inch in length, both species being somewhat strikingly colored and marked. The common asparagus beetle, shown in Fig. 2, has the thorax or fore part of the body, reddish-yellow marked with two black spots. The wing covers are marked by a bluish-black stripe along the middle line where they meet, and lateral extensions of this main stripe extend toward the edges, which are orange colored. The intervening color is lemon-yellow. The underside of the body and the legs are usually shining black. The 12-spotted beetle is uniformly reddish in color, with twelve black spots on the wing covers (Fig 3). The body is broader than the common species. These beetles cause much damage by gnawing into the young marketable shoots, and later the beetles of the common species help to defoliate the plants, while the 12-spotted beetles feed mainly on the berries.

FIG. 2.—Common Asparagus Beetle on asparagus: Showing eggs, larvæ and adult; asparagus top at right, showing eggs and injury. (Chittenden, Yearbook, 1896, U. S. Dept. of Agr.)

Hibernation.—The beetles pass the winter hidden about in any convenient shelter, under loose bark of trees, in fence corners, and like places, coming forth in early spring as the asparagus commences growth.

Eggs and Egg-Laying.—The eggs of both beetles are similar in shape, but those of the common species are placed on end, usually in rows, while the others are laid singly and flat against the plant. While the beetles may appear at about the same time, the 12-spotted beetles do not often commence to deposit eggs until a month has elapsed, while the common species commence quite early.

Larvæ and Feeding Habits.—The larvæ of the common asparagus beetle when first hatched do much damage by gnawing into the tender shoots, and in this work they are assisted by the adult beetles. The larvæ, called *"grubs,"* may attain a size of one-fourth inch or slightly longer. They are soft bodied, yellowish or dark gray in color. The larval period varies, but is usually about twelve days, after which they drop to the ground, burrow down and change to pupæ in dirt-covered cocoons.

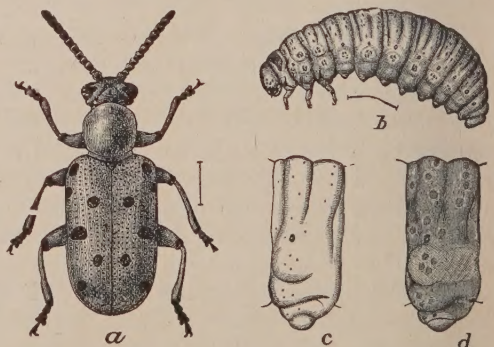

FIG. 3.—12-Spotted Asparagus Beetle: *a*, beetle; *b*, larva. (Chittenden, Yearbook, 1896, U. S. Dept. of Agr.)

As already stated, the eggs of the 12-spotted beetle are deposited late and the larvæ feed on the berries, if present, causing them to drop before ripening. In appearance these larvæ do not differ materially from the ones just described, except for being reddish in color.

Generations.—The life cycle from egg to adult requires only about thirty days, hence there may be several broods each season. The beetles hibernate quite early in the fall.

REMEDIES AND PREVENTION.

Asparagus beetles should be controlled by preventive measures largely, although direct remedies are at times necessary. Commencing early in spring when the beetles first appear, the asparagus grower should aim to destroy all eggs deposited, before they hatch, and supplement this by poisoning the beetles on trap plants. The eggs of the common asparagus beetle are frequently laid in the bud of young shoots just as they appear, or on the stems of any plants in the field. Obviously all old plants, with the exception of a few left as trap plants, should be cut down, and new shoots cut out clean at least every three days. Beetles and larvæ on trap plants may be shaken into a pan of kerosene, and the plants may be dusted frequently with a mixture of lime dust and Paris green, using one pound of the poison in thirty pounds of air slaked lime. The lime dust alone is an effective remedy for the soft bodied larvæ, killing all that it touches, and the mixture acts as a poison to both larvæ and beetles.

Trap plants bearing eggs and larvæ should be cut out frequently—at least once a week, and new plants allowed to grow up in their place. Since the larvæ of the 12-spotted beetle feed mainly in the berries they can not well be poisoned; hence frequent destruction of plants bearing the eggs is advisable. Larvæ of the common species may be shaken from the plants on sunny days when the earth is hot, and many will die before getting back to the plants.

Arsenate of lead (See p. 61), as a liquid poison spray, may be used on fields that are allowed to grow during summer and fall.

INSECTS AFFECTING BEANS.

Bean plants are subject to injury from leaf eating insects from the time they appear above ground; the fruit may be damaged by boring caterpillars; the stored beans partially destroyed by weevils; the seed when planted is sometimes injured by ants and wireworms, and young plants severed by cut worms.

Wireworms (See under Insects Affecting Corn, p. 31).

Cutworms *(Larvæ of Night Flying Moths).*

To gardeners these pestiferous creatures are very familiar. Some, however, may not be acquainted with their life history, or the best

remedial measures. The former is very interesting and indicates how the larvæ should be fought. When beans, and many other garden plants commence to appear in spring, they are cut off at night just above the surface of the soil by these pests. During the day the cutworms lie in shallow burrows in the soil or under any available cover, coming forth to feed only at night. There are a number of species, variously known as greasy, variegated, dark-sided, glassy, clandestine, etc., all having about the same habits, but differing in appearance.

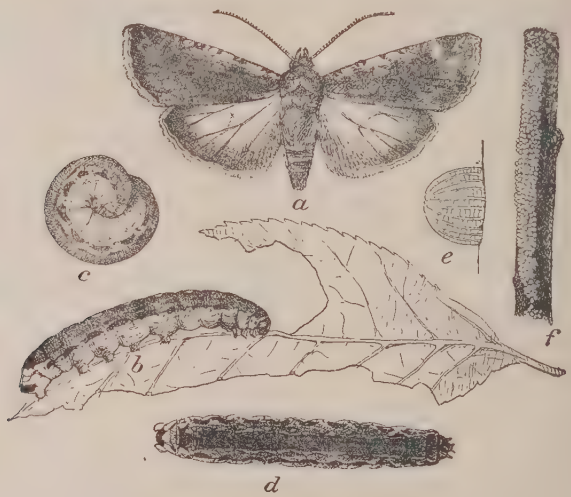

FIG. 4.—Variegated Cutworm, *Peridromia saucia*: *a*, adult moth; *b*, *c*, and *d*, larvæ (3 views); *e*, single egg much enlarged; *f*, egg mass on grass stalk. (Howard, Div. of Ento., U. S. Dept. of Agr.)

DESCRIPTION AND LIFE HISTORY.

Life History.—Noticeable damage by cutworms occurs mainly in spring when gardens are first started. The worms responsible for the damage are ones that pass the winter in hibernation, awaiting the advent of spring to issue forth in search of food. To appreciate the appetite displayed by cutworms one must understand their life history, which is as follows:

About June or July cutworms become fully grown. They then burrow into the earth, form silk-lined oval cocoons and transform therein to pupæ. About three weeks later the adult parent moths emerge and soon deposit eggs for the next brood. The eggs (Fig. 4, f) are placed on any succulent vegetation, grass or weeds, on which the larvæ, when hatched, feed and become about one-half grown before winter weather drives them into hibernation. The following

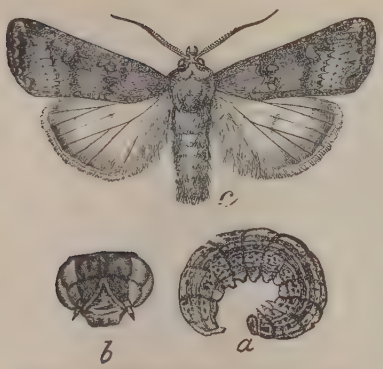

FIG. 5.—Black Cutworm, *Agrotis ypsilon:* Showing larva and adult moth. (Riley and Howard, Div. of Ent., U. S. Dept. of Agr.)

spring they awake with ravenous appetites after their long winter's fast, and naturally devour any green vegetation at hand.

Parent Moths.—The moths shown in Figs. 4 and 5 are of medium size and have wings, which expand one and one-half to two inches. The front wings are dark brown or gray, never conspicuous, but usually bearing a kidney-shaped spot of lighter color; hind wings always lighter than the fore wings. These moths hide during the day, but if disturbed fly with a quick, darting motion.

Larvæ.—All have naked bodies, varying in color from dirty green to gray and brown, but often distinctly marked with longitudinal dark stripes and dots. They have three pairs of true legs at the anterior (head) end and five pairs of fleshy pro-legs behind (Fig. 4, b). When disturbed they always curl up, as shown at Fig. 4, c.

Generations.—Only one generation occurs each year, and the greater portion of their life is passed in the larval stage.

REMEDIES AND PREVENTION.

Preventive measures are preferable to direct remedies, though the latter are fairly successful. Gardens that are in constant cultivation and that are kept free from weeds would not be greatly infested with cutworms, were it not for the ones that wander in from adjoining grass lands, but as this always occurs gardens are seldom exempt from them. The natural food of cutworms is grass, and for this reason sod land during the first year's cultivation is liable to be badly infested.

Cultural Methods.—Gardeners may determine with reasonable certainty what fields are most liable to be infected. Sod land, or grassy and weedy gardens may always be suspected. Such lands should be plowed deeply in fall or early winter to disturb the cutworms in their earthen hibernating cells. Some will be exposed as prey to fowls and birds and some may die from exposure to the winter weather. It has been stated also that the rains soaking into the loosely plowed land will drive some larvæ from their cells. Cross plowing to further disturb and expose the cutworms is certainly advisable.

Domestic fowls should be encouraged to follow the plows, as they will destroy great numbers of insects.

Paper Bands.—In small gardens, plants like tomatoes, cabbages, egg-plants, etc., may be protected from cutworms by bands of stiff cardboard or tarred paper pressed into the soil surrounding the plants. They need not be over one and one-half inches above the soil, as cutworms seldom climb. Occasionally a species of climbing cutworm appears, which must be fought by poison sprays or poisoned bait. Vertical holes with smooth, hard sides made close by the plants, are said to be good traps, as the cutworms crawl into them, and are unable to get out.

Poisoned Bait.—This is no doubt the best remedy to be used against cutworms before the crops are planted, acting as a preventive measure, though it may be used later. To make the best use of poison bait, prepare the garden or field by raking off all vegetation a few days before the crop is planted or seeds come up. Leave the land a few days, which will result in making the cutworms hungry. Then apply a bait made as follows: With forty pounds of corn-meal mix one pound of Paris green or white arsenic; moisten with water to make a rather stiff mash, and sweeten with two quarts of common molasses. Apply this bait about sundown in little heaps at frequent intervals over the field. Repeat this application for two or three nights in succession. In this way, many cutworms will be poisoned, especially if the land is free from vegetation. The bait may be placed in heaps close by plants that should be protected, but the paper bands are more effective.

Another good poison bait is made by cutting some succulent clover and dipping it in a barrel of water containing one pound of Paris green. This may be used while fresh the same way as the corn-meal bait.

All poisoned baits must be used with caution, or not at all, if chickens are liable to get to it.

Bean Leaf Beetle *(Cerotoma trifurcata,* Forst).

Injury is caused by the adults eating round holes in the leaves of beans and cowpeas, while the larvæ feed on the roots or main stem just below the surface of the soil.

DESCRIPTION AND HABITS.

The beetles are about one-sixth inch in length, varying in color from yellowish to reddish with black marking as shown in Fig. 6. When abundant, the beetles may defoliate plants severely. They hibernate during winter and usually appear quite early in spring.

The larvæ are slender in form and whitish in color, and feed on the roots or stems in the manner stated above.

There may be two or three generations. According to Chittenden[1] the life cycle requires from six to nine weeks.

[1] Yearbook Dept. of Agr. 1898, p. 254.

REMEDIES.

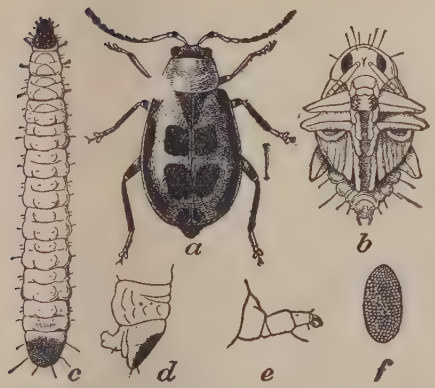

FIG. 6.—Bean Leaf-Beetle: *a*, adult beetle; *b*, pupa; *c*, larva; *f*, egg—*a*, *b*, *c* enlarged about six times, *f*, more enlarged. (Chittenden, Yearbook, 1898, U. S. Dept. of Agr.)

Spraying the plants with an arsenical poison, Paris green or arsenate of lead preferably mixed with Bordeaux mixture (See p. 61), is undoubtedly the best remedy. When the early appearing beetles are poisoned later spraying should not be necessary. String beans should not be poisoned when the pods are maturing. Further preventive measures against similar leaf-eating beetles are discussed on page 43 under cucumber beetles.

COMMON BEAN WEEVIL (*Bruchus obtectus*, Say).

The common bean weevil, *Bruchus obtectus*, Fig. 7, as well as other species of *Bruchus*, annually infest quantities of dried beans,

FIG. 7.—Common Bean Weevil, *Bruchus obtectus*: *a*, beetle; *b*, larva; *c*, pupa—all greatly enlarged. (Chittenden, Yearbook, 1898, U. S. Dept. of Agr.)

rendering them unfit for food or seed. Infested beans are readily detected, upon examination, as every housekeeper could testify. Many people believe that beans become infested *only* after they are stored, and such may at times be true, but a large proportion are first infested in the field or garden.

LIFE HISTORY AND HABITS.

Dried stored beans once infested with weevils may continue to become worse infested by successive generations. If not disturbed the

weevils may produce five or six generations each year and single beans may contain a number of weevil larvæ at one time.

Ordinarily, beans first become infested in the field, the weevils depositing eggs through slits or cracks in the green pods, and the larvæ, as soon as formed, bore into the beans. Their presence is indicated only by a small black speck on the skin. In dried beans, the weevils are readily detected because they eat away all but a very thin layer of outer skin.

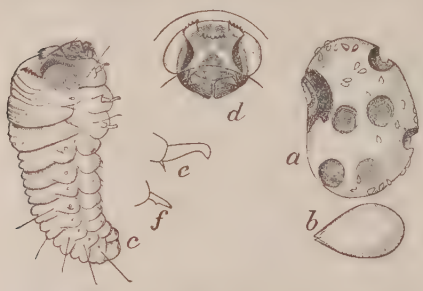

FIG. 8.—The 4-Spotted Bean Weevil, *Bruchus 4-maculata:* Showing cowpea (*a*) with holes made by weevils, and also eggs on the surface; *c*, embryonic larva. (Chittenden, Yearbook, 1898, U. S. Dept. of Agr.)

The adult bean weevil *B. obtectus,* is about one-sixth inch in length, grayish brown in color, and has the end of the abdomen extending beyond the wing covers. Other species of bean weevils differ in size and coloration, but all may be distinguished by the short wing covers. Fig. 8 represents the four spotted bean weevil, *B. 4-maculata.*

REMEDIES.

There is no way of preventing infestation of beans in the field if the parent beetles are present. To prevent their being present stored beans, peas and cowpeas should be thoroughly fumigated during fall and winter, so that no adult beetles may escape. The method of fumigation is fully described under pea weevils, p. 48. (See also corn weevils, p. 39.)

INSECTS AFFECTING BEETS.

CUTWORMS (See under Bean Insects, p. 11).
FLEA BEETLES (See under Cucumber Insects, p. 44).
WEB WORM (See under Cabbage Webworm, p. 23).
WIREWORMS (See under Corn Insects, p. 31).

BEET LEAF-MINER (*Pegomyia vicina,* Lint.).

This insect may not occur in North Carolina, but if not this particular species, some similar ones do occur. The beet leaf-miner is common in States where the sugar beet is grown and may cause considerable injury. Many garden plants are injured more or less by leaf-mining insects, hence the brief account here given of the beet leaf-miner should be of general interest.

Beets and other plants are often found with raised or blistered

blotches, or channels in the leaves, these areas eventually turning brown and dying, rendering them unfit for greens. The cause of this damage is a small larva or maggot feeding between the two surfaces of the leaf.

The adult of the species mentioned above is a two-winged fly, resembling the common house fly, only smaller. The eggs deposited by these flies hatch into minute maggots, that bore at once into the leaves. When grown the maggots usually leave their channels to pupate.

PREVENTIVE MEASURES.

As sprays are useless to poison the larvæ, the gardener's recourse is to destroy the infested leaves. When beets, turnips, etc., are used for greens, all discarded leaves should be burned rather than left in the fields. The insects pass the winter in the pupæ stage under leaves and rubbish, and may be destroyed by clean cultural methods.

INSECTS AFFECTING CABBAGE, COLLARD AND CAULIFLOWER.

A long list of insects are known to attack these and closely related crops, and since no garden operation is complete without these valuable plants, their insect enemies should be well understood.

Cutworms.—(See under Bean Insects, p. 11).

Flea-Beetles.—Poison applications used against cabbage worms, p. 22, should also control the flea-beetles. The reader should refer also to control of flea-beetles on cucumbers, etc., p. 44.

Cabbage Aphis (*Aphis brassicæ*, Linn.).

Green lice on cabbage, collards, and related crops, familiar to all gardeners, may appear early in the spring, but are generally most abundant and destructive in late summer and fall. Particularly is this true in fall after cool weather commences, and is due mainly to the fact that natural parasitic enemies are able to keep the lice reduced to small numbers during warm weather.

LIFE HISTORY AND FEEDING HABITS.

Cabbage aphis, like all plant lice, feed by piercing the plant tissue with their long, slender beaks and sucking the plant juices. When numerous they may cause plants to wither and die, and only small numbers may serve to stunt the growth. These lice multiply very rapidly, the young being born alive by both winged and wingless viviparous females. The winged females serve to spread the colonies, that is, a single winged individual may fly to an uninfested plant and start a new colony. No true males and females are present during

the summer months, but are developed by the last brood. A winged male is shown in Fig. 9, a. The true females develop eggs that serve to carry the species through the winter. Colonies of cabbage lice are usually more or less covered with a white powder, which they secrete, and great numbers of molted skins are always present.

FIG. 9.—Cabbage Louse: *a*, winged male; *b*, wingless female—much enlarged.

PARASITES.

Were it not for the number and activity of parasites attacking the cabbage aphis, this would be a very serious pest. Predaceous parasites, such as lady-bird beetles and their larvæ, and aphis lions, together with internal parasites belonging to the Hymenopterous insects, usually serve to keep the aphis down to comparatively small numbers during warm, dry weather in summer. Later, the lice become more numerous, mainly because their parasites are not so active or else they stop work entirely because of the cold weather.

REMEDIES.

Soap Solution.—For all lice, as previously stated, contact sprays of sufficient strength are effective. It is surprising how easy the cabbage lice may be killed with soap solution, which acts by suffocation and caustic effect. Ordinary strong potash washing soap, or powder, will do the work. Dissolve one pound in about four gallons of water and apply to infested plants with considerable force and in liberal quantities. The lice are often so thickly massed together that those underneath will escape unless the solution is applied as a fine spray and with *force*. A spray pump is quite necessary and should be provided with a short hose and extension rod with a curved end, in order to throw the spray on the under sides of the leaves. Failing in this, the leaves must be turned over and the colonies of lice saturated with the solution. *Simply sprinkling the tops of infested plants does very little good.*

Other Contact Sprays.—Kerosene emulsion of 10 part concentration, tobacco decoction, pyrethrum powder and whale oil soap (See p. 63 for direction for preparing) are all good remedies, but not superior to common soap solution when properly applied.

TERRAPIN OR HARLEQUIN BUG (*Murgantia histrionica*, Hahn.).

This gayly colored plant bug, so common and destructive, is another sucking insect, feeding on the plant juices. Its attack is more serious than the plant lice because, in addition to sucking the sap, it

injects into the plant tissue a poison that causes the foliage to turn brown, shrivel and die. A very few terrapin bugs may kill young plants. They attack all cruciferous crops.

DESCRIPTION AND HABITS.

Adult Bugs.—The fully grown bugs are about three-eighths inch in length, and one-fourth inch wide. The head is short, with the long beak springing from beneath and lying between the legs when not in use. The body presents a blunt, broad-shouldered appearance. The general color is black with orange or yellow markings. (See Fig. 10.)

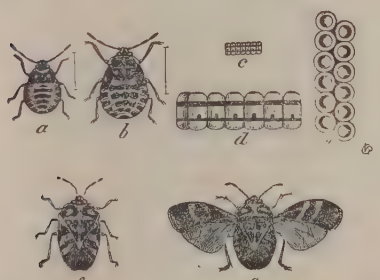

Fig. 10.—Terrapin Bug: *a* and *b*, nymphs; *c*, eggs; *d*, eggs enlarged; *f* and *g*, adult bugs.

The adults live in hibernation during winter in any protected place.

Eggs.—Are usually laid on the under sides of the leaves in double rows of twelve, as shown in Fig. 10, e. Each egg appears barrel-shaped and is marked by black bands, Fig. 10, d.

Nymphs.—The young, called nymphs, resemble the adults except that they are smaller and lack wings. In this stage they have comparatively soft bodies and succumb to strong contact sprays.

REMEDIES AND PREVENTION.

Old fields of collards and similar crops are veritable feeding grounds for terrapin bugs. By thorough cleaning up of such fields in fall much trouble may frequently be averted. Strict cleaning up and burning of all stray plants and rubbish about gardens and fence corners during winter will destroy many hibernating adults.

Trap Plants.—The adult bugs, first appearing in spring, seem to be partial to mustard, radish and rutabaga plants, and these may be planted early and used as trap plants. Only a few are necessary. The bugs that gather on such plants may be collected by hand or shaken into a pan containing a little kerosene, and when eggs are deposited and nymphs appear they may be killed by spraying with 15 per cent kerosene emulsion, or with pure kerosene, but the latter will kill the plants. When the trap plants become too badly infested, they may be pulled and burned. Persistent warfare in early spring should so reduce the number of bugs as to protect the later crops.

Kerosene Emulsion.—When used liberally of 15 per cent concentration (See p. 63) this will kill all the young and nearly mature

nymphs that it comes in contact with and will kill some adult bugs. Before the wings are developed, the bugs are not so difficult to kill. Two or three such sprayings at intervals of five or six days should nearly exterminate the bugs, even on badly infested crops.

When spraying with emulsion, many bugs drop from the plants to the ground, and should be thoroughly saturated where they lie, and this is quite important, as very few will live to return to the plants. Kerosene emulsion must be properly prepared, so that the oil does not readily separate, otherwise the plants may be injured by the spray.

CABBAGE WORMS.

No less than five distinct species of leaf-eating worms are annually present, and are quite injurious to cabbage, collard, turnip and related plants. One species, the cabbage web worm, has never before been reported as occurring in North Carolina. In addition to the five different worms mentioned below, cabbage and related crops may at times be attacked by the larvæ of the Southern cabbage moth, zebra caterpillar, army worm, corn worm, yellow woolly bear, and possibly other minor leaf-eating pests. The following, however, are the only ones that the gardener need fear:

Imported Cabbage Worm *(Pontia rapæ,* Linn.).

As the name implies, this destructive pest was introduced into this country from Europe, first appearing in the United States about 1865. It is now prevalent throughout North America and Europe. Although an introduced pest it has far outstripped in numbers the native cabbage worm, described further on.

DESCRIPTION AND HABITS.

Parent Butterfly.—The parent of the imported cabbage worm is a white-winged, active, day-flying butterfly. The majority of the white butterflies that hover about cabbage and collard fields on bright, sunny days are the adults of this species.

The female butterflies have white wings expanding about one and three-fourths inches, the front wings having a black spot at the tip and two black dots near the center, while the hind wings have only one black dot near the front margin (Fig. 11). The males differ in having only one black dot on the forewings, but otherwise closely resembling the females. The butterflies deposit eggs on all cruciferous crops, but particularly on collard, cabbage, and cauliflower.

Eggs.—These are laid on the under sides of the leaves; they are oval in shape, white at first, but soon assume a yellow color, and hatch

FIG. 11.—Imported Cabbage Worm: *a*, female butterfly; *b*, egg—much enlarged. *c*, larva in natural position; *d*, pupa suspended; (Chittenden, Cir. 60, Bur. of Ent., U. S. Dept. of Agr.)

in four to eight days. They may be easily located on the plants by watching the female butterfly as she deposits them one at a time.

Larvæ.—The larvæ or young worms feed on the lower surface of the leaves, or in the opening bud, and rapidly increase in size, attaining full growth in about two weeks. They then appear green in color, one and one-fourth inches long, with a pale yellow stripe along the middle of the back. The body is clothed in short hairs, giving it a velvety green appearance. They move slowly without lifting the body, which they are enabled to do by possessing eight pairs of legs. This species seems to prefer to feed on the central leaves.

Pupæ.—The grown larvæ change to naked pupæ suspended to the underside of a leaf by a silken cord about the body and the tip of the abdomen attached to a mat of silk. Fig. 11, d, represents a pupa suspended, but not in its natural condition. The pupæ are irregular in shape, light green, and inactive except for being able to wriggle the abdomen when disturbed.

LIFE HISTORY.

Pupæ, also known as chrysalides, of the last fall brood, live through the winter. In the spring they transform into butterflies, which soon commence to deposit eggs. In warm weather the entire life cycle from egg to butterfly is completed in about thirty days, or less, so that five or six broods may develop during the year in the South. There are three broods in the New England States.

This, we see, is an insect having four distinct stages of development as already described, and naturally the larval or feeding stage is the time when it may be destroyed most readily, although adults may be caught in nets, and pupæ sought for and destroyed.

REMEDIES.

Poison Sprays.—A prejudice seems to exist against the use of poison sprays on cabbage, collard, etc., but it is largely without foundation. Garman, Entomologist of Kentucky, has made exhaustive experiments with Paris green mixture and found that it may be used safely if reasonable care be exercised in its application. Certainly the arsenical sprays are more effective against the worms than most other remedies on young and half grown plants. Garman sprayed cabbages four times with Paris green mixture, using as much as one pound of Paris green in one hundred gallons of water, and about two weeks after the last application he had entire cabbage heads, outer leaves and all, subjected to chemical analysis. Only a slight trace of poison could be detected; not enough to poison a person under any conditions. As cabbages grow from the inside outward, and the outer leaves are always removed before cooking, the writer does not hesitate to recommend the use of arsenical sprays until within three or four weeks of the time when such plants will be eaten. Cruciferous plants grown for greens alone may be poisoned also, using the same precaution. Resin-lime mixture, or Paris green-lime mixture, as recommended under formulas, page 62, will suffice to keep this and other cabbage worms in control. Four annual sprayings are usually sufficient.

Fresh hellebore acts as a poison both by contact and internally. It may be dusted on infested plants every two or three days, or used as a liquid spray.

Contact Sprays.—Cabbage worms, being soft-bodied and breathing through pores in the body, will succumb to contact sprays such as ten per cent kerosene emulsion, strong soap solution, or by dusting with common ar-slaked lime or ashes. Hand picking of worms from small areas is often advisable.

Preventive Measures and Trap Crops.—All remnants of cruciferous plants should be removed from the gardens and fed to stock or burned as soon as the crop is gathered, especially during late fall and winter, for the destruction of such plants will destroy many overwintering pupæ of the imported cabbage worm, and also those of nearly all injurious cabbage worms. Trap plants may be left in the field in fall to attract the butterflies to deposit eggs, but these should be freely poisoned and destroyed entirely before spring.

Parasites.—Several parasitic enemies assist in keeping the imported cabbage worm in control.

Native Cabbage Worm *(Pontia protodice,* Bd.).

Unlike the cabbage worm just described this is a native North American species, and is said to be more abundant in the South than

in the North. Near Raleigh during October, 1907, no worms of this species could be found, but earlier in the season they were probably numerous. Doubtless the parasites got very active and nearly exterminated this species in this section last fall.

DESCRIPTION AND LIFE HISTORY.

The adult male butterflies resemble the imported species, already described, in size and color, but differ in having four angular spots on the front wings and small black marks near the tip, while the hind wings are not marked. The females differ very greatly in having both pairs of wings liberally checkered with angular black spots.

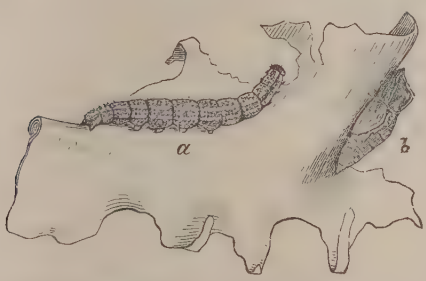

FIG. 12.—Native Cabbage Worm: *a*, larva; *b*, pupa. (Yearbook, 1883, U. S. Dept. of Agr.)

The eggs are laid singly on the undersides of the leaves.

The larvæ (worms) are greenish or purple in color and differ from the preceding form by having four longitudinal pale yellow stripes along the back. The head and body are dotted with black. The pupæ resemble those of the imported species and are similarly attached to the leaves (Fig. 12).

The life history of this species is practically the same as that of the imported cabbage worm.

REMEDIES.

The remedy is the same as for the imported species and one can not well be controlled without destroying the other.

Parasites.—Several beneficial parasites attack the native cabbage worm, often rendering other remedial measures unnecessary.

CABBAGE WEBWORM (*Hellula undalis,* Fab.).

Another imported pest of cruciferous crops is the webworm, a most injurious species, new to North Carolina, and of a comparatively recent occurrence in North America. The writer first discovered this pest quite abundant on turnips at West Raleigh in October, 1907, and it appears never to have been discovered previously in any part of this State. The webworm had of course been here all through 1907 and probably one or two years before, but without being detected.

HISTORY OF THE CABBAGE WEBWORM.

This insect was discovered in injurious numbers near Augusta, Ga.,

in 1898, but had been observed there the previous year. In Richmond County, Ga., in 1898, the damage caused by webworms to turnips, cabbage, beets, etc., was estimated conservatively at $20,000, and by some persons as high as $50,000. This serious outbreak led to an investigation by the Bureau of Entomology, Washington, D. C., which brought out the fact that the same insect had appeared near Charleston, S. C., in 1895, considerable damage in that vicinity being reported also in 1896. Three years later, in 1899, injury from webworms was reported from Auburn, Ala., and Athens, Ga., but the damage near Augusta, Ga., was not nearly so great as it had been in the year 1898.

From the information available it is thought that the cabbage webworm was first introduced near Charleston, S. C., and spread from there to Augusta, Ga. Now that it has been found at West Raleigh there is every reason to believe that in many places in North Carolina it already has a good foothold. Therefore our farmers and gardeners should study the following description and learn to recognize the pest.

INJURY CAUSED BY WEBWORMS.

The worms seem to prefer feeding in the bud of young plants or on the undersides of the leaves, or in the crown of plants like turnips and beets. On turnips, they may burrow into the crown, making shallow channels, and also eat off the leaves at their bases. The worms cover themselves with a web, probably remaining under it most of the time, though they may leave it at night to feed. When grown the worms spin silken cocoons, which are usually imbedded in a mass of web. Young plants are prevented from growing by the worms eating the bud, and older plants may be ruined in a few days if the worms are abundant. The presence of webworms is indicated by webs between the bases of the leaves of cabbage, collard, etc., and in the crown of beets and turnips. The worms may usually be found under the webs.

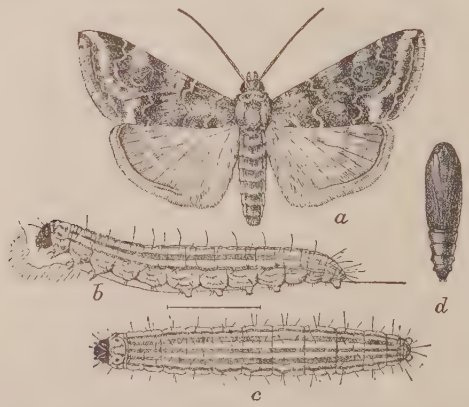

FIG. 13.—Cabbage Webworm: *a*, parent moth; *b*, and *c*, larvæ; *d*, pupa—all 3 times natural size. (Chittenden, Bul. 19, Bur. of Ent., U. S. Dept. of Agr.)

DESCRIPTION AND HABITS.

Eggs.—Eggs are laid singly or in masses, according to Chittenden,[1] and are at first white, changing to pink; the shape is oval, size small, but discernible to the naked eye; they hatch in three to four days.

Larvæ.—Full grown webworms are quite distinctive in appearance. They measure a little over one-half inch; color yellowish gray, marked above by five noticeable brownish stripes (Fig. 13, b, c); body dotted by a few yellowish or brownish hairs. The larvæ have eight pair of legs, three pair true legs in front and five pair pro-legs behind.

Pupæ.—These are not readily found because of being enclosed in tough silken cocoons spun between the leaves or in the crown of turnips and beets. The pupæ are shiny yellowish brown in color, and are about three-tenths of an inch in length (Fig. 13, d). As they pass the winter in this stage an excellent opportunity is presented to reduce their numbers by clean cultural methods.

Parent Moths.—In general shape and markings the moth is well shown in Fig. 13, a, much enlarged. The true size is about three-fourths inch when wings are expanded, but when resting with wings folded over the body they appear much smaller. The fore-wings are gray, marked with both darker and lighter stripes and spots. Hind wings are lighter in color. The moths fly and deposit eggs at night, and hide during the day.

Generations.—No definite information concerning the number of annual broods for North Carolina is available. We do not know how early the webworms become abundant, nor much about their life history. On this point, and many others, the writer hopes to get definite information this coming summer by field and laboratory observations. The life cycle as determined by Chittenden is about 27 days, but will, no doubt, be found to vary.

REMEDIES.

Arsenical Poisons.—Poisons if effective must be applied early, for when the protecting webs have been spun, poison sprays will not be of value. If the worms are detected when they first appear, some of them, and especially succeeding broods of larvæ may be poisoned. In other words, a poison spray applied thoroughly so as to penetrate well in between the bases of the leaves where the webworms commence to feed will kill many of the young. For this spray, it would be best to use Paris green, at a strength of 1 pound to 125 gallons of water with lime (See p. 60) or arsenate of lead at the usual strength. Dry dust poison applications may answer the same purpose if applied

[1] Bureau of Ent. Bul., 23, p. 59.

with a good powder dust gun that will throw the mixture forcibly into all crevices. As soon as the first worms appear apply poison liberally.

Trap Crops.—Webworms seem to prefer cabbage and turnips, hence it would seem that these might be planted early and thoroughly poisoned to destroy the early broods. This would be a great protection to later crops of similar and related plants.

Clean Culture.—Webworms may undoubtedly be prevented from increasing in numbers by carefully burning or feeding, if suitable, all remnants of infested plants during fall and winter. When early crops are infested burn or feed the plants when the crop is gathered. Such practice is advisable against other cabbage worms that pupate on the plants and winter in that condition.

Cabbage Looper (*Autographa brassicæ,* Riley).

This is probably the most injurious cabbage worm in North Carolina. Cabbages, collards, and rutabaga turnips are often almost stripped of their outer leaves, and the worms may bore into the cabbage heads. They move by a looping motion, rendering them easily recognized from the other common cabbage worms.

Fig. 14.—Cabbage Looper (*A. brassicæ*): *a*, male moth; *b*, egg (two views); *c*, larva in natural position; *d*, pupa under thin cocoon—*a*, *c*, *d*, slightly enlarged; *b*, more enlarged. (Chittenden, Bul. 33, Bur. of Ent., U. S. Dept. of Agr.)

Description and Habits.

Eggs.—Are small, pale green, round and flattened on one side with convex side up, and are deposited singly or in small clusters by the female moths about sundown or at night.

Larvæ.—When full grown they are one and one-half inches, or more, in length, pale green, marked with four fairly distinct stripes along the back. Less distinct longitudinal lines also occur. The body is smallest at the anterior end and bears three pairs of true legs on the first three segments, and three pair of pro-legs near the caudal end, one pair being on the last body segment (Fig 14, c.).

Because of not having pro-legs in the middle of the body these caterpillars move with a semi-looping motion, much like the familiar "inch or measuring worm."

Pupæ and Cocoons. The larvæ change to pupæ under thin silken webs on the under sides of the leaves, as shown in Fig. 14, d. The pupæ are about one-half inch long, shiny brownish in color, and may be seen through the thin webs.

Parent Moths.—From the pupæ, moths as shown at Fig. 14, a emerge to lay eggs for the succeeding brood. The moths have a wing-expanse of nearly one and one-half inches; fore-wings grayish brown and marked by a silvery dot and loop near the center; hind wings are lighter. They fly at night or about sundown, and hence escape observation.

Generations and Winter Stage.—Several generations occur each year and are checked only by cold weather. The last brood passes the winter as pupæ, which shows that fall and winter destruction of old infested plants should be practiced.

REMEDIES.

All remedial measures, trap plants, clean culture, etc., suggested above to be used against the imported cabbage worm, should be employed against this species.

Diamond Back Moth or Cabbage Plutella (*Plutella maculipennis,* Curtis).

Although a small worm, this species may cause considerable damage by feeding on the undersides of the leaves and producing small, round holes. They do not often cut through to the upper surface. The larvæ much resemble the young imported cabbage worms, but may be distinguished from them by being extremely active if disturbed.

The parent moths are only about one-fourth inch in length and are seldom seen. They lay minute whitish eggs, which hatch within a few days. The larvæ are a little over one-fourth inch in length, of a pale green color, and when grown encase themselves in white cocoons, which are attached to the leaves. There may be several broods during each season.

REMEDIES.

Poison Spray, as previously recommended, is effective, and Garman states that tar-water has been found very effective in European countries. The winter is passed in the pupa stage, hence clean culture is most advisable.

Cabbage Root Maggot (*Pegomyia brassicæ*, Bouché).

Small, white footless maggots sometimes infest the roots and base of cabbages and radishes and other related crops. There are probably two or three species of cabbage maggots in North Carolina, but a description of the one mentioned above will serve to give the gardener or trucker an idea of these pests and their habits.

DESCRIPTION AND LIFE HISTORY.[1]

Maggots are the young or larvæ of two-winged flies (Fig. 15). This species somewhat resembles the common house fly, only they are much smaller. They pass the winter as adults or pupæ, the latter remaining close to the roots of the plants on which the maggots subsisted. The flies appear in spring at about the time young cabbage plants are set out, and lay eggs on their stems or on the soil close by. The maggots feed on the outer roots, or stems when the latter is not too tough and hard.

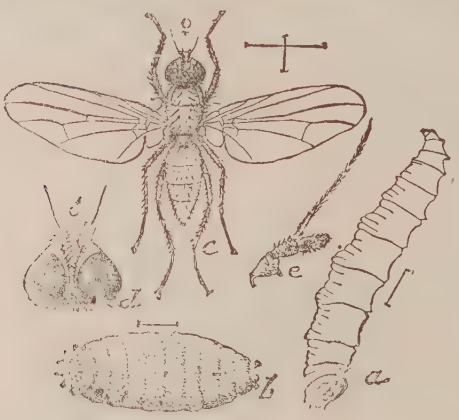

Fig. 15.—Cabbage Maggot: *a*, larva; *b*, pupa; *c*, adult. (Riley).

The presence of maggots is indicated by wilting and drooping leaves, and a general weakened appearance of the plants. It is said that plants infested when young will surely die, unless some good remedial measure is applied.

REMEDIES AND PREVENTION.

Tobacco dust applied liberally about the plants when first set out is of some benefit as a repellent.

Carbolic acid emulsion as recommended against the onion maggot, p. 47, may be used as a repellent.

Quick Acting Fertilizer.—Concerning the use of fertilizers Dr. Smith says: "A combination recommended consists of:

Nitrate of Soda	700 lbs.
Acid Phosphate	1,000 lbs.
Muriate of Potash	300 lbs.

[1] N. J. Sta. Bul., 200.

"The practice of plowing away from onion rows when infestation was noted and applying the above combination, or even nitrate of soda alone, has been followed with good results in Cumberland County, but has failed on heavier soils where the fertilizer did not get so quickly through the soil, and into direct contact with the plants and maggots. Both the nitrate of soda and the muriate have insecticidal qualities, but the acid phosphate has none. Manure and organic fertilizers should be avoided, if possible, as the group of insects to which these root maggots belong are naturally feeders in decaying matter, and hence such conditions tend to invite them."

Prevention.—Pull up and burn or otherwise completely destroy all stumps of plants, of whatever crop may have been attacked by maggots. Practice rotation of crops, for the parent insects do not fly very far. The cabbage maggot will breed in wild cruciferous plants, including some common weeds, such as mustard, hence all such should be destroyed. A good precaution when setting cabbage, or similar plants, is to press the soil firmly about the stem, as it will help to retard the maggots, when hatched, from getting down to the soft roots.

Planting an excess of seed when drilled in rows may insure getting a stand even where a large number of plants are attacked by maggots. The plants that become infested should be pulled out and destroyed. The reader should refer also to p. 47 concerning treatment for the onion maggot.

Cabbage Snake (*Mermis albicans,* Diesing).

During recent years much excitement has been caused by the discovery of slender, white worms in cabbage heads, known as "cabbage snakes," and which have been reported as being deadly poison. How such accounts have originated it is hard to realize. The "cabbage snake," so called, comonly found, is shown in Fig. 16. It is an "eel-worm" or "hair worm," and occurs as an internal parasite in the bodies of grasshoppers, happening at times to escape from its host onto cabbage heads, which alone accounts for its presence there. These slender, thread-like creatures are active and repulsive looking, but never poisonous.

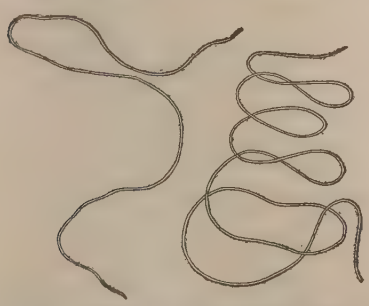

Fig. 16.—"Cabbage Snake" or Hair-Worm: Natural size. (Chittenden, Cir 62, Bur. of Ent. U. S. Dept. of Agr.)

Small, segmented, reddish earthworms occasionally get into cab-

bage heads, by being accidentally lodged there with small clods of earth during cultivation. There is no danger from eating cabbage that have contained these worms, or the common "cabbage snake."

INSECTS AFFECTING THE CELERY PLANT.

Cutworms.—(See under Bean Insects, p. 11).

Celery Caterpillar *(Papilio polyxenes,* Fab.).

This is a very large, conspicuous green and black caterpillar, familiar to many children because of its peculiar appearance. It seldom appears in great numbers, but if present is a voraceous feeder on various plants, including celery, carrot, parsley, caraway, parsnips, and related wild plants.

DESCRIPTION AND HABITS.

Caterpillars.—Are about two inches in length, green in color, with rings of black, which in turn bear yellow spots. The head bears a pair of horn-like processes that may be thrust out and which emit a disagreeable odor. The body is thrown into a peculiar defensive like attitude when disturbed.

Pupæ.—When full grown the caterpillars generally desert the plants on which they fed and crawl to some convenient place to pupate. The pupæ are naked, of an ash-gray color, and are suspended by a silken band and mat of silk at the caudal end. In this quiescent stage they pass the winter.

Parent Butterfly.—The adult form, commonly known as the "black swallow-tail," is very conspicuous. The wings are blackish-brown, and marked with yellow and orange bands and spots.

REMEDIES.

As there may be several broods each season the gardener should be on the watch for their first appearance. The caterpillars are so conspicuous that hand picking is probably the best remedy, and if the larvæ of the first brood are destroyed later injury may be prevented. Paris green mixture (See p. 60) will be found effective and might be used with profit on the young plants in extensive celery fields.

Other Caterpillars Attacking Celery.

Celery Looper, *Plusia simplex,* closely related to the cabbage looper, and the celery leaf-tyer, *Phlyctænia ferrugalis,* is a small caterpillar that usually feeds on the terminal leaves and may at times become troublesome. Spraying young plants with arsenical poisons should prove effective, and is perfectly safe if the poison is used in reasonable amounts.

Celery Lice.

Celery is occasionally infested with plant lice of various species, whose attack results in lessened vitality and dwarfed plants. Should this occur, a thorough spraying with soap solution, as suggested for cabbage aphis, p. 18, will be found effective. Soap solution may be applied frequently without injury. Tobacco decoction is always quite effective against plant lice.

Red Spider *(Tetranychus spp.)*.

These little creatures, frequently called mites, are not true insects. They are, however, a very common garden pest, and attack at times almost any vegetables, particularly cucumbers, cantaloupes, egg plants and many common crops. They are most abundant during hot, dry weather, and then if present they cause the foliage to turn yellow and eventually die. The individuals are very small and rather active; and may feed on both upper and lower surfaces of a leaf, spinning over it a thin web for protection.

REMEDIES.

Abundant moisture will keep red spiders in check. When a good spray or force pump is available, they may be controlled by simply making frequent applications of ordinary clear water, applied with all the force the plants will endure, washing both sides of the leaves. This method is used in greenhouses, to keep the mites off of violets, roses and other plants.

Powdered sulphur (flowers or flour of sulphur) applied as a fine spray, using one ounce of sulphur in a gallon of water or the dry powder dusted on the plants when wet with dew will be found very effective. Potassium sulphid *(liver of sulphur)* obtainable from drug stores, may be used as a spray of one ounce in three gallons of water. It is said that a little whale oil soap, tobacco-stems water, or milk of lime added to the sulphur mixture increases its efficiency.

INSECTS AFFECTING SWEET CORN.

Numerous insects attack corn, some injuring the seed when first planted, some damaging the young plants, others attacking the stalk and ears when partly grown, while still others damage the stored grain. Only the most common injurious forms will be mentioned here, as the entire space of a bulletin is needed to adequately discuss all the corn insects.

Wireworms *(Several Species)*.

These insects hardly require description, as they have become so well known by their attacks on various crops. Wireworms injure

corn by the larvæ boring into the kernels when first planted and later by entering into the stalk of young plants, causing them to die in the same way as when injured by budworms or rootworms.

DESCRIPTION AND HABITS.

Larvæ.—Wireworms in general may be described as having long, slender, cylindrical, firm bodies, showing segmentation, usually flattened toward each end. They vary in size according to the species to which they belong, some being less than one, others nearly two inches long. The majority are reddish or yellowish in color, presenting a very hard, slick appearance. Some wireworms feed on decaying wood and organic matter, while others subsist on seeds and roots of plants.

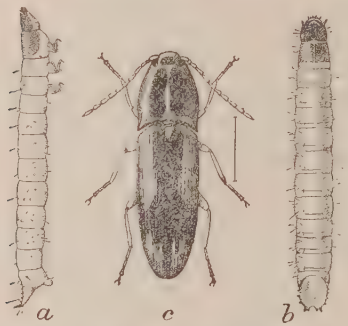

FIG. 17.—Wireworms: Larvæ and adult—all three times natural size. (Chittenden, Bul. 33, Bur. of Ent., U. S. Dept. of Agr.)

Parent Beetles.—These are commonly known as Jack snappers, click beetles, thumping beetles, and by other terms, gained for them by the power of springing several inches in the air, in an effort to turn over when laid on their back.

The common click beetles are from one-third to one inch in length, generally of a brown color and are variously marked. A common species is pictured in Fig. 17.

LIFE HISTORY.

The parent beetles may hibernate in protected places, but many larvæ pass the winter in the soil. It is thought that most species of wireworms require three years to mature, hence two winters of their life must be passed in the ground. This fact shows how difficult it may be to free a field from these pests. The beetles of the injurious species, generally deposit their eggs in grassy places, though the species that feed in decaying wood may lay eggs in old stumps, etc.

REMEDIAL MEASURES.

No single method of control is effective. Various methods of reducing the numbers of wireworms in fields already badly infested have been advocated. The most promising are, early fall plowing to disturb the larvæ, followed by cross plowing and harrowing once or twice during winter, and the use of poison baits in spring. A good bait is made by treating slices of potatoes or turnips with strichnine, and other baits are mentioned under remedies for cutworms, p. 14.

Crops peculiarly liable to attack, like corn, potatoes, beets, turnips, etc., should never be planted on land known to be infested, unless absolutely necessary.

Rotation of crops may do some good. It is difficult to name an immune crop. Legumes, as a rule, are not much injured by wireworms, but that may be due to their abundant root system. A rotation that allows the land to be broken every fall or winter will naturally tend to reduce the numbers of these insects.

Planting an excess of seed when corn must be planted on infested land may insure getting a stand.

Corn Rootworm (Budworm), *(Diabrotica 12-punctata,* Oliv.).

This corn pest belongs in the same category as the wireworms in being difficult to control. Rootworms damage young corn plants by

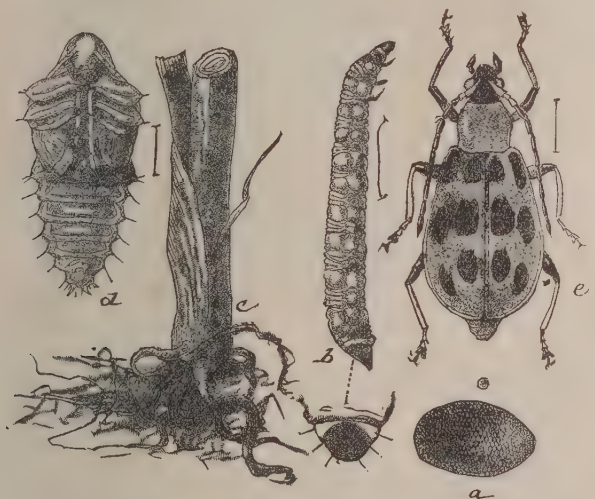

Fig. 18.—Corn "Root-worm" or "Bud-worm": *a*, egg; *b*, larvæ; *c*, injury o corn plant; *d*, pupa; *e*, adult beetle—all except *c* much enlarged. (Redrawn from Riley, Div. of Ent., U. S. Dept. of Agr.)

eating into the stalk at or near the ground, and very young plants may be killed outright, while older ones will be caused to make a dwarfed growth because of having the central bud destroyed. Fig. 18 illustrates the insect in its different stages, and an injured plant.

DESCRIPTION.

Larvæ.—These are slender, yellowish white grubs with a brown head and body about one-half inch long. They attain full growth in three to four weeks.

Pupæ.—The larvæ change to naked whitish pupæ in little cells in the soil, and after about two weeks transform again to beetles.

Parent Beetles.—Are about three-tenths of an inch long, yellowish green in color, with twelve black spots on the wings as illustrated in Fig. 18, much enlarged. These beetles are omniverous feeders on a great variety of plants, notably cucumbers, cantaloupes, etc.

LIFE HISTORY.

After passing the winter in hibernation the beetles become active early in the spring. The earliest vegetables of the garden serve as their food, working, as they do, side by side with cucumber and flea beetles. The eggs, deposited in the soil close by the base of corn plants, hatch within a short time and the newborn larvæ burrow into the stem as indicated above.

There are at least two generations, the first maturing within about six to seven weeks after the eggs are deposited. The parent beetles are present all summer, often feeding on the blossoms of fruit trees.

REMEDIES.

Commencing in early spring and following this insect through its two generations, we discover no good chance of destroying the larvæ, but there is some opportunity of killing the pupæ in the soil and of poisoning the adult beetles. The latter method, however, offers only a slight chance, for the beetles do not all feed in the gardens. Still the liberal use of poisons on cucumbers and cantaloupes, as recommended on page 43, will undoubtedly destroy some of them. Some of the pupæ may be killed by thorough weekly cultivation of the corn crop, especially during and about the sixth to tenth week after it comes up.

Good fertilization to strengthen and feed the corn plants will aid materially against slight attacks, and planting an excess of seed will often insure a stand even though the rootworms may be abundant.

Late Planting and Lowlands.—Delaying the planting of corn until two or three weeks after the usual time will allow many beetles time to deposit eggs elsewhere, thus gaining some protection. The ideal time to plant corn must be determined by experience. Corn rootworms are *liable* to be most abundant in lowlands—but they are not very choice in the selection of a feeding ground—hence some advocate the avoidance of such lands for corn.

As Sherman,[1] in writing of corn insects, has said, "All these measures will help '*some*,' but no one alone will insure immunity from attack of rootworms."

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[1] Bul. N. C. Dept. Agr., Vol. 26, No. 5.

Southern Corn Stalk Borer (*Diatræa saccharalis* Fab.).

Stalk borers. (Photo. by the author.)

Corn is often injured by a caterpillar boring in the stalk, usually most noticeable and injurious when the ears in clusters half grown, but young plants may be destroyed. These insects weaken the stalks, retarding the development of the ears and sometimes cause large stalks to produce nubbins except for fodder. These insects are said to be most abundant during the latter part of May or early in June.

DESCRIPTION AND HABITS.

Larvæ or Borers.—These burrowing caterpillars are about one inch long, with whitish, robust bodies, speckled with brown and black spots (Fig. 20). They outlive their attack mainly by the three horny joints, and may move without apparently affecting the ground. The larvæ, however, are very active, often leaving their burrows and making new entrance holes, thus greatly weakening the stalks (Fig.).

Pupæ.—The pupæ, usually found in the stalk above ground, are of a shiny, brownish color and are about one-half inch long.

Parent Moths.—The adult moths have a wing expanse of about one and one-half inches; the fore wings are dull yellowish brown, or nearly

colorless; hind wings white or cream colored. The moths of the first brood appear in Georgia (where the writer studied this insect) from the middle of June to the middle of July. They probably appear about the same time in North Carolina.

LIFE HISTORY.

The reader will understand that there are two broods each season. The first brood are the progeny of the insects that pass the winter in the pupal stage, in corn stubble (presumably), while the second brood are the progeny of the moths that appear during June and July.

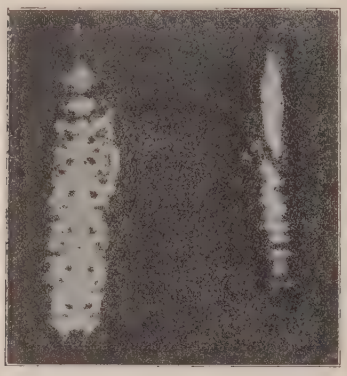

FIG. 20. -Larva and pupa of corn stalk borer. On left larva; on right, pupa—twice natural size. (Photo. by the author).

Corn is damaged most severely by the first brood, for at that time the plants are small or only partly grown. Late planted corn may be injured badly by the second brood. It seems highly probable that the corn stalk-borer has some wild host plants, some common weeds, in which many larvæ of the second brood mature. Howard[1] has reported its occurrence in Gama grass, and there must be other wild host plants. The insects pass the winter as pupæ, probably, to some extent at least, in corn stubble.

REMEDIAL MEASURES.

No truly effective remedy can be offered. It has been suggested that corn planted as late as May 15 to June 1 might escape injury, still it might also be attacked by larvæ of the second brood. When the stalk borers are observed the gardener should arrange to plow out, rake and burn the stubble as soon as the corn is harvested. Cutting the plants off at the surface of the ground will probably serve to trap nearly all the larvæ or pupæ that may be present, but such infested stalks should be fed to stock or hogs or used for ensilage. When corn is badly infested by stalk borers it would be best to use it for fodder or the silo, taking the precaution to cut the corn before many of the borers change to pupæ. The gardener can ascertain this point by frequently examining the corn plants for the presence of the brown pupa, which will certainly be found when the worms are full grown.

[1] Insect Life, Vol. IV.

Rotation of crops is of course beneficial, but it must be remembered that the moths are capable of flying some distance in spring in search of young corn in which to deposit eggs.

Deep fall or winter plowing of corn land may serve to bury some of the pupæ so that the moths can not escape.

Corn Ear Worm (*Heliothis obsoleta*, Fab.).

This insect does not by any means confine its attack to corn, though this is perhaps its favorite food plant. It may bore into cotton bolls, and is then known as the cotton-boll-worm. When it attacks beans, peas, tomatoes, okra, tobacco and other crops, it is generally known by the name of the plant on which it occurs. The wide variation in the color of the larvæ largely accounts for its having so many names.

DESCRIPTION, HABITS AND LIFE HISTORY.

The parent is a night-flying moth, the wings of which expand about one and one-half inches and range in color from dull yellow to olive green with black markings (Fig. 21). The moths that appear in early spring, having developed from pupæ that passed the winter in earthen cells, seem to prefer to deposit eggs on young corn, and later on the silk, particularly when that is present. The larvæ, small at first, grow rapidly, attaining a length of about one and one-quarter inches, and range in color from greenish to dark brown. The markings are shown in Fig. 22.

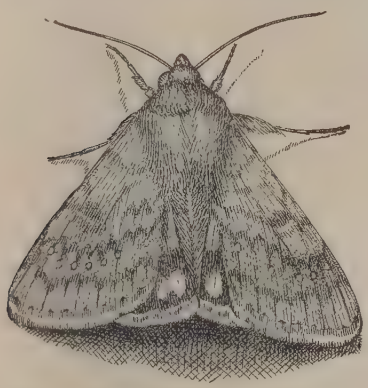

Fig. 21.—The Corn Ear-worm, showing adult moth in natural position with wings not spread —about twice natural size. (Quaintance, Bur. Ent., U. S. Dept. of Agr.)

Sweet corn is injured more severely than common field corn, but as the former is so much more preferable for table use the gardener should prepare to fight this insect.

There may be four or five broods each season, each successive brood gaining in numbers. When corn becomes hard, the moths deposit eggs on cotton, seeming to know instinctively that it will make better food for the larvæ.

REMEDIES.

The only direct remedy consists in pinching the tips of infested ears of corn to crush the larvæ within. A few rows of sweet corn may be treated in this manner. The pinching must, however, be done

several times and at intervals of only two to three days, as the small larvæ may escape.

Trap Plants.—Remembering that the moths prefer corn silk on which to deposit eggs, we have an opportunity of using a few hills of

FIG. 22.—The Corn Ear-worm, showing the destructive larva at work in ear of corn. (Quaintance, Bur. Ent., U. S. Dept. of Agr.)

very early planted corn as trap plants. Early maturing varieties should be used. The larvæ are cannibalistic, devouring each other when more than one are present in a single ear, hence the trap plant is peculiarly valuable. Trap plants must be watched and destroyed, or at least the worms destroyed before any become full grown and descend to the ground to pupate. Garden crops other than corn may be protected by having a few hills of corn in silk when the other crops would ordinarily be injured.

Winter Plowing.—As already stated, these worms usually appear

in cotton fields after the corn becomes hard, and hence it will be seen that the last generation is most liable to pass the winter as pupæ in such lands, rather than in garden or corn fields. Winter plowing of cotton fields, and gardens, where late corn has been grown, will kill many pupæ.

Corn Weevils *(Larvæ of Beetles and Moths).*

Stored corn, shelled or otherwise, is often infested with white grub-like larvæ, which may be the young of the rice-weevil *(Calandra oryzæ,* Linn.), or the granary weevil *(Calandra granaria,* Linn.), or the larvæ of the Angoumois grain moth *(Sitotroga cerealla,* Ol.). The latter is common, though the two former are better known. The two weevils are shown in Fig. 23, and the grain moth in Fig. 24. Corn may become infested with weevils in the field, but the grain moth is most liable to attack the stored corn.

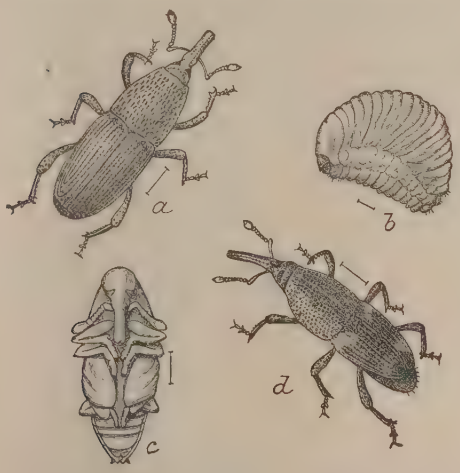

Fig. 23.—Corn Weevils: *Calandra granaria; a,* beetle; *b,* larva; *c,* pupa. *C. oryzæ, d,* beetle. All enlarged, (Chittenden, Farmers' Bul. 45, U. S. Dept. of Agr.)

As there is no known practical method of protecting the corn in the field we will not take space to describe these insects, but pass at once to the matter of remedies.

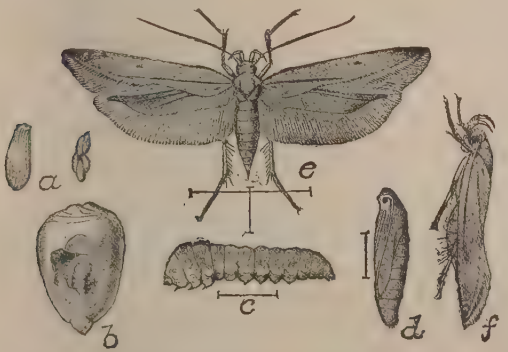

Fig. 24.—Angoumois Grain Moth: *a,* eggs; *b,* larva at work; *tc,* larva; *d,* pupa; *e, f,* moths—all enlarged. (Chittenden Farmers' Bul. 45, U. S. Dept of Agr.)

REMEDY.

Fumigation.—Carbon bisulphid, a clear, foul smelling liquid that costs about 25 cents a pound is a certain remedy when properly used. Infested corn may be fumigated in *air tight bins* by using at least one and one-half or two pounds of carbon bisul-

phid for about one hundred bushels of grain. The grain moth is killed more easily than the true weevils, and for the latter it may be necessary to considerably increase the recommended amount. This remedy is often condemned and declared worthless because attempts made to fumigate the corn in loose, leaky bins have failed. It evaporates rapidly and the fumes are heavier than the air, so that they will settle and escape if any cracks are left in the bottom and sides of the bin or receptacle used for the fumigating chamber. The top must be closed or covered with something, such as wet blankets and boards, to keep out any currents of air. To fumigate, expose the liquid in shallow dishes near the top of the space, or pour it directly onto the corn, afterawrd leaving the place tightly closed for twenty-four to thirty-six hours. The fumes do not act immediately, like some other poison gases, and for this reason it is necessary to prevent even gradual leakage. When corn can not be treated in an *air tight* chamber, the amount of carbon bisulphid should be increased, but even then, under these conditions, the results may not be satisfactory.

Adult weevils and larvæ may be killed by fumigation except in certain cases when they are uncommonly well protected in the kernels, but as eggs which are not killed by fumigation may be present, it is generally necessary to repeat the treatment once or twice before corn is entirely freed from weevils.

Ordinary fumigation does not injure corn for eating or planting.

Caution.—The fumes of carbon bisulphid are highly combustible and explosive, hence lighted cigars, lanterns, etc., should not be brought near where the fumigation is going on. Breathing the fumes should be prevented, as they may cause a slight or severe headache. Some people are quite easily affected.

INSECTS AFFECTING CUCUMBERS AND CANTALOUPES.

Cutworms *(several species)*.—(See under Insects Affecting Beans, p. 11).

Red Spider.—(See under Insects Affecting Celery, p. 31).

Melon Plant Louse *(Aphis gossipii,* Glov.).

Young cucumber, cantaloupe and similar plants may be attacked by small green sap-sucking lice that often cluster in great numbers on the under sides of the leaves. This same louse occurs on young cotton and is then known as a cotton louse. It is capable of causing severe stunting of growth and even death of badly infested plants. It occurs all through the summer months, sometimes injuring cantaloupes when the vines are several feet in length.

DESCRIPTION AND LIFE HISTORY.

Plant lice, of nearly all species, breed by giving birth to living young, the adults being both winged and wingless, as shown in Fig. 25. Many generations are developed each season and during the summer the colonies of lice contain no true males or females. This development is known as parthenogenesis, that is, the young are born by females without the intervention of the male. The melon louse is no exception to this rule. True males and females are developed by the last fall brood and the oviparous females deposit eggs to carry the insects through the winter. These eggs hatch in spring into minute lice that develop into viviparous females, whose young are born alive, as already explained.

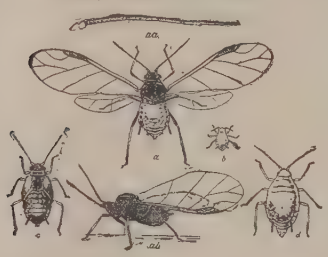

FIG. 25.—The Melon Aphis, *Aphis gossypii*: much enlarged. (Chittenden, Bur. of Ent., U. S. Dept. of Agr.)

The melon louse is yellowish green in color and about one-twentieth of an inch in length. The winged individuals of the colonies serve to spread the species, and their presence accounts for the isolated colonies that appear during the summer months. Individuals mature in six to eight days, and each gives birth to about fifty young. Considering this rapid increase it would seem that all infested plants would be destroyed, and such would be the case were it not for the valuable work of parasites, both internal and predaceous, that destroy great quantities of them. With these facts in mind, let us enter upon a consideration of the methods of control.

REMEDIES.

Spraying.—Contact poison sprays as used against cabbage lice (See p. 18) may be employed to kill isolated colonies that appear in spring.

Fumigation.—Within recent years a method of fumigating cantaloupe plants has been quite well perfected. Sanborn[1] has made valuable experiments with specially prepared tobacco or nicotine fumigating papers, manufactured and sold under the names nico-fume tobacco paper, aphis punk and to-bac-ine (See p. 64), and has perfected a system of fumigating by the use of cloth covered frames. The following description of a fumigating outfit is based on Sanborn's work:

Cloth Covered Frames.—For fumigating vines from two to four feet long construct a light wooden frame square or rectangular, of the desired dimensions, and nail an eight-inch leg to each corner. This may be covered with heavy muslin saturated with linseed oil to render

[1] Texas Expt. Sta. Bul. 89.

it air-tight. Cut the muslin in pieces large enough to cover the frame, and also extend one foot over each side, and tack to the top, but not to the legs of the wooden frame. The loose edges of the muslin may be covered with earth to prevent any escape of gas. A frame of this construction makes a perfect fumigating arrangement, as it can be placed over any portion of a long vine if desired without damage and without disturbing the vine.

Method of Fumigating.—Use the tobacco papers, as recommended (p. 64), fumigating the infested plants from 20 to 30 minutes. This will kill all the aphis under the frames without injuring the plants. This method is said to be comparatively cheap and it is undoubtedly effective, much more so in fact than the best spraying that could be done. By having several frames in operation one or two men may fumigate large areas in the course of a day.

Beneficial Parasites.—As already stated parasites render valuable aid in controlling the melon lice. In Texas, Sanborn has shown that it pays to induce the increase of parasites by planting Rape, which usually bear the cabbage lice in abundance. This plant furnishes food in fall for a number of predaceous parasites, such as lady-bird beetles and their larvæ, that feed on the cabbage lice, and the beetles hibernate during winter among the weeds and rubbish and thus are usually present in the spring and ready to attack the first broods of melon lice. Rape, as a trap plant, should be planted in summer and fall in the gardens or on the edge of the fields where cantaloupes and cucumbers are to be planted the following year.

Striped Cucumber Beetle *(Diabrotica vittata,* Fab.).

Here we have one of the commonest and most destructive of all insects that feed on the foliage of cucumbers and related plants. It is also a difficult one to control.

Fig 26.—Striped Cucumber Beetle: *a*, beetle; *b*, larva; *c*, pupa—all much enlarged. (Chittenden, Cir. 31, Div. of Ent., U. S. Dept. of Agr.)

Description and Life History.

Beetles.—These small, yellow winged beetles, only two-fifths of an inch long, marked with longitudinal black stripes on the wing covers (Fig. 26), usually appear early in the spring. They are voracious feeders and cause much damage to young plants. They hibernate during winter.

Eggs and Larvæ.—Eggs are deposited at the base of young cucumber plants and hatch into small, slender, whitish larvæ that feed on the tender rootlets. The larvæ may attain a size of about one-third inch. They cause plants to wither and sometimes die. Such injury is generally overlooked by gardeners or else is laid to cutworms. The larva matures in about one month, and after passing through the pupa stage, lasting about two weeks, the change to the adult takes place.

REMEDIAL MEASURES.

All plants subject to attack should be protected from the ravages of the beetles from the moment they appear above ground until several leaves are formed, after which the plants are better able to withstand the injury. This protection is best afforded by suitable covers, but certain repellent sprays and powders may be used with profit.

Cover Protection.—The cheapest and most effective protection is afforded by box frames, about one foot square, covered with fine wire or mosquito netting, or, in the manner sometimes suggested, by cutting a barrel hoop in two to form two semi-circles, and pressing these down, crossing each other over the plants and covering all with netting. The lower edge of the cover may be held down with earth. The writer believes that the perfect protection given by these covers, allowing the plants to grow for three or four weeks without injury, more than repays the cost of material and the trouble of fixing them in place.

Spraying and Dusting.—A combination repellent and poison in the form of Bordeaux-Paris green mixture (See p. 61) is the next best thing to a cover protection. The poison Bordeaux serves as a protection against the cucumber beetle, and all leaf eating insects that may be present, and furthermore serves as a fungicide to keep the foliage healthy. When liquid spray is used this is the most economical.

A dry mixture of lime and Paris green (See p. 60) will poison many beetles and also act as a repellent, and simply dusting plants with tobacco dust, kerosene and lime mixture, or hellebore offers considerable protection, but the liquid poison spray is the most efficient. Dry applications should be applied when plants are wet with dew and repeated after every shower.

Trap Plants.—A few *very early* planted cucumber plants liberally treated with poison spray may serve to lessen the number of striped beetles and also Flea beetles, 12-spotted Diabrotica (adult of corn rootworm) and all leaf eating insects present at that time.

Planting an excess of seed is advisable if the protective measures suggested can not be used. The plants should not be thinned out too

early, as some may die from the attack of the larvæ on the roots or from other causes.

Clean Culture.—Gardens should be cleaned up and all weeds and rubbish removed and burned during late fall or winter. This does away with the chance of leaving convenient hiding places in which this and many other garden insects may hibernate during winter. Fence rows should be cleaned out, and sod land adjoining gardens may be burned over to help destroy hibernating insects.

Cucumber Flea Beetle *(Epitrix cucumeris,* Harr.).

These small, black, jumping beetles (Fig. 27), about one-twelfth inch in length, often cause quite severe injury by eating the foliage of cucumbers, cantaloupes, melons, etc. The larvæ of this species is a leaf-miner, causing some damage, while the adults feed on the surface.

Fig. 27.—Cucumber Flea Beetle much enlarged. (Chittenden, Bul. 19, Bur. of Ent., U. S. Dept. of Agr.)

Other Flea Beetles.—Several different species of flea beetles occur at times, and injure cabbages, turnips, potatoes, beans and many garden plants. The larvæ of most species feed on the roots of Jimson or other common weeds. The beetles all get their name from their ability to jump, due to thickened and muscular hind legs like those of the grasshopper.

REMEDIES.

Protective covers, poison and repellent sprays, and powders, and in fact all methods of control suggested above against the striped cucumber beetle are effective against flea beetles.

Pickle Worm *(Diaphania nitidalis,* Cramer).

Growers of cucumbers and cantaloupes need no introduction to this troublesome pest that bores into cucurbits, rendering them unfit for table use or for market. The injury is caused by the larvæ. This borer is frequently called the melon worm or cantaloupe worm, but we will consider it as the pickle worm because a closely related species is now known as the melon worm. (See p. 57).

DESCRIPTION.

Eggs and Larvæ.—The eggs are generally laid in masses in blooms or tender buds. They are at first white, but change to yellowish green before hatching into small whitish worms. When grown the larvæ are yellowish green in color, about three-fourths of an inch long, and have eight pairs of legs.

Pupæ.—Light silken cocoons are spun in a fold of a leaf of the food plant, or on weeds close by, and here the pupæ are formed, changing later to adult moths.

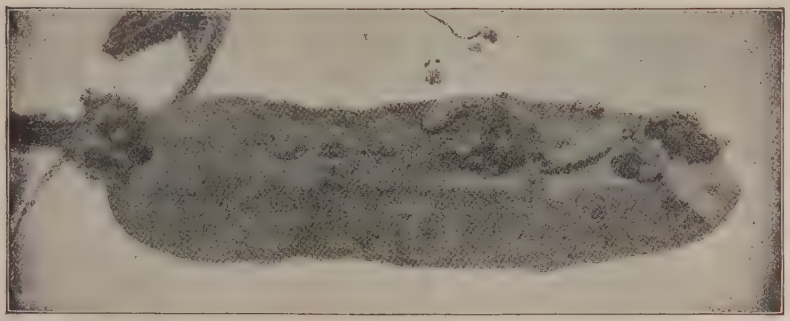

FIG. 28.—Pickle Worms working on cucumber. (Quaintance, Bul. 45, Ga. Exp. Sta.)

Parent Moths.—The moths have a wing expanse of about an inch; the color is yellowish brown, marked with yellow areas. The body terminates in a prominent brush like that of the melon worm (Fig. 37).

LIFE HISTORY AND HABITS.

The average life cycle of the pickle worm was determined by Quaintance[1] in 1901 as being from 24 to 27 days, showing that there may be at least four or more broods each year. The winter is passed in the pupal stage, always above ground in weeds or rubbish, which allows the gardener a chance of destroying great numbers by clean culture. The moths are nocturnal, hiding during the day. It seems that the first ones emerging from the over-wintering pupæ are somewhat late, appearing when the cucumbers or cantaloupes are well started into growth. The young larvæ may feed in opening buds, or at the base of the leaves, but soon attack the fruit. The greatest injury of course comes from their boring into the fruit, this being exaggerated by their habit of passing from one fruit to another. A great preference is shown for the blooms of squash (Fig. 29), and this may be made use of in protecting the cantaloupes and cucumbers as stated under remedies.

REMEDIAL MEASURES.

Very early planted cucumbers and cantaloupes for home or market use may escape injury from this pest, owing to the late appearance of the moths. Late plantings may be seriously injured, and there seems

[1] Georgia Expt. Sta. Bul. 54.

to be no absolute remedy to suggest. Trap crops, clean culture, and poisoning will all help to lessen the injury.

FIG. 29.—Pickle Worms feeding in squash blooms. (Quaintance, Bul. 45, Ga. Exp. Station).

Poison.—Dusting young plants with lime dust and Paris green may serve to poison some young larvæ that feed in the buds and flowers before entering the fruit.

Trap Crop.—Squash plants started early and planted among and near the crop to be protected are of great value if properly managed. The pickle worm larvæ feed freely in the squash blooms, and when this plant is used as a trap the infested blooms must be regularly gathered at least once a week and carefully destroyed to prevent any larvæ from maturing. Quaintance found that this crop offers very great protection, and when adopted squash seed should be planted every two or three weeks in order to furnish an abundance of blooms while the cucumbers and cantaloupes are developing. The squash plants might be poisoned also as a further protection.

Destroying Infested Fruit and Over-wintering Pupæ.—All infested fruit should be gathered and fed to hogs or otherwise destroyed to kill the larvæ within. As soon as the crop is gathered, rake up and burn the vines, together with all weeds and rubbish, to destroy any larvæ and pupæ that may be present. Deep plowing directly after the crop is gathered will no doubt stop further increase, and as another safeguard it is best to practice rotation of crops.

INSECTS AFFECTING THE EGG-PLNT.

Egg-plants are not subject to serious injury from insect attack, but some minor damage may occur each year. Some insect pests that may be expected are mentioned below:

Aphis (Plant Lice).—(See under Cabbage Aphis, p. 17).

Colorado Potato Beetle.—(See under Potato Insects, p. 49).

Cutworms.—(See under Bean Insects, p. 11).

Flea Beetles.—(See under Cucumber Insects, p. 44).

Harlequin Bug.—(See under Cabbage Insects, p. 18).

INSECTS AFFECTING THE ONION.

Cutworms.—Onion sets are liable to be seriously thinned out by cutworms, hence land on which onions are to be set should be carefully prepared, and freed as far as possible, from these pests by the use of poisoned baits as recommended on p. 12. When onions are grown in the field from seed an abundant supply should be planted to insure a stand, but the use of poisoned bait previous to sowing the seed should not be neglected.

Onion Maggot *(Pegomyia ceparum,* M.).

When plants in the onion beds commence to turn yellow, wilt, and die, from no apparent exterior cause, white maggots in the roots may be looked for.

As the life history and habits of this insect are so nearly the same as the cabbage maggot, the reader is referred to the description on p. 28.

Remedy.—In addition to the remedies suggested against cabbage maggots, gardeners may make good use of a carbolic acid emulsion, recommended by Slingerland,[1] whose formula is as follows:

Dissolve one pound of soap in one-half gallon of water, and thoroughly emulsify with one pint of crude carbolic acid. For use take one part of the emulsion to fifty parts of water.

This emulsion should be applied with a spray pump around onion plants, after first removing the surface soil. It is said to kill the maggots and also repel the parent fly from laying eggs.

Unleached ashes scattered over the beds just after the onions have come up is also said to repel the parent flies.

Infested fields should not be planted to onions the following year, and new seed beds should be placed as far away as possible.

INSECTS AFFECTING PEAS.

Pea Weevil *(Bruchus pisorum,* Linn.).
(And Other *Bruchus* spp.).

Belonging to the same genus as the Bean Weevil, but differing considerably in life history, the pea weevil *(B. pisorum)* is a common

[1] N. Y. Cornell Expt. Sta. Bul. 78.

pest in stored peas. This species is a little larger (Fig. 30) than the bean weevil described on p. 15 and illustrated in Fig. 7. They differ materially, however, in the number of annual generations, for the pea weevil has only one, while the other may have several. Furthermore, only one larva of the pea weevil invades a single pea, and always gains entrance while the peas are green in the field. In other words, the pea weevil does not breed in dried peas, like the other species that have been mentioned.

FIG. 30. Pea Weevil, *Bruchus pisorum*: *a*, beetle; *b*, larva; *c*, pupa; much enlarged. (Chittenden, Yearbook, 1898, U. S. Dept. of Agr.)

The 4-spotted bean weevil (Fig. 8) may infest peas or beans, and unlike the common pea weevil, this species will breed in dried peas, producing successive generations like the bean weevil, hence any remedy against pea weevils must be one that will destroy all species present.

REMEDIES.

Fumigation.—If only the pea weevil *(Bruchus pisorum)*, that does not attack dried peas, were present, fumigation of peas would not be necessary. Simply placing them in perfectly tight receptacles until the adult weevils died would be sufficient. This condition may not occur, however, so we must prepare to fumigate to kill weevils whenever present.

Fumigation is the best remedy known, and carbon bisulphid is the material usually used. This clear, colorless, foul smelling liquid will kill the weevils, both larvæ and pupæ, but not the eggs. It is used, at the strength of one teaspoonful to a cubic foot of space, by placing the infested beans or peas in a perfectly air-tight receptacle, such as a large earthen jar, exposing the liquid on top in a shallow dish, and leaving the chamber closed for twenty-four hours. The liquid soon evaporates and the fumes, which are heavier than air, readily penetrate to the bottom.

Much loss might be prevented if gardeners would practice fumigation of peas and beans when first stored, but even when that is done they should be treated again if any weevils are observed later. As several broods may develop and weevil eggs may be present almost any time, fumigation must usually be repeated two or three times. The reader should refer to p. 40 for further information about carbon bisulphid and precautionary measures to be observed.

Uninfested peas or beans, if stored in perfectly tight receptacles, will remain free from weevils.

To insure getting good seed for planting, pour them in water, when the infested ones will float and may be discarded.

INSECTS AFFECTING IRISH POTATOES.

This valuable vegetable is subject to the attack of leaf-eating insects, such as Colorado Beetles, Flea Beetles, etc., and the tubers may be damaged by wireworms and white grubs. These pests, together with the stalk borer and others, must be fought successfully if potato growing is made profitable.

Colorado Potato Beetle *(Leptinotarsa 10-lineata*, Say.).

This common potato pest is well known and frequently referred to as the potato bug, though the name beetle is more appropriate. It has been given the name Colorado potato beetle because of its being native to Colorado, where it formerly fed upon wild weeds belonging to the same genus as the potato plant. The Irish potato seemed to be much preferred by this insect, and when that vegetable was introduced it was speedily attacked.

Colorado potato beetles were first seriously injurious to potatoes in 1855, in Colorado, and since then have spread to the East and North, until now they occur in practically all of the potato growing sections of the United States and Southern Canada. Its natural spread was undoubtedly hastened by the parent beetles being shipped with potatoes. At the present time it appears to be omnipresent, for the potato patch can not be located where the beetles may not appear. For this reason the practice of rotating crops, so beneficial against certain other insects, does very little good in this case.

DESCRIPTION AND HABITS.

Parent Beetles.—It has been said that these beetles perch themselves on clods of earth and await the sprouting of potatoes in spring. This is almost literally true, for the adults pass the winter in protected places, and are among the first to appear in spring.

The beetles are ochre-yellow in color, with ten longitudinal black lines on the wing covers (Fig. 31). They do considerable damage by feeding on the foliage.

Eggs.—The eggs are deposited in flat clusters of fifty or more, on the under sides of the leaves. They are conspicuous orange colored. Each female may lay from six hundred to one thousand eggs.

Larvæ or "Bugs."—The soft bodied, reddish, hump-backed creatures, commonly called bugs, are voracious feeders, causing much

more damage than the adults. In four to five weeks, they attain full growth after eating an enormous quantity of food, and then drop from the plants, enter the earth and form a smooth, oval cell (Fig. 31).

FIG. 31.—Colorado Potato Beetle: *a*, eggs on leaf; *b*, small and grown larvæ; *c*, pupa; *d*, adult beetle; *e*, enlarged wing-case of adult; *f*, enlarged leg of adult. (Riley, Missouri Reports).

Pupæ.—In the earthen cells the pupæ pass a motionless life for ten days to two weeks, and then transform to the parent beetles.

Generations.—There are probably four generations each year in North Carolina, the last beetles passing the winter in hibernation.

REMEDIES.

The voracious feeding habits of this pest, coupled with the power of the potato plant to withstand arsenical poisons, offers us a reliable remedy in the poison applications.

Arsenicals.—Paris green or arsenate of lead applied as a liquid spray is a perfect remedy. The former may be used at the greatest strength recommended on page 60 and the latter at the usual strength.

Dry Paris Green Mixture (See p. 60) may be dusted on while wet with dew or just after a rain by means of a good powder gun, or through a cloth sack, or a tin can with the top perforated like a pepper shaker. These poison applications will certainly control the Colorado potato beetles, but the grower should watch carefully for the first appearance of egg masses, and then be prepared to apply the poison to kill the young larvæ before the plants are defoliated. It is just as easy to poison the bugs before the foliage is injured—and certainly more economical.

No Danger From Arsenical Sprays on Potatoes.—The writer has met a few people who feared to apply the Paris green to potato plants,

thinking that the tubers would absorb the poison from the foliage. There is absolutely no such danger, and practically no danger to the persons applying the poison.

Bordeaux Mixture and Paris Green.—We would particularly advise the use of Paris green in Bordeaux mixture (See p. 61), as it helps to keep the plants free from disease, and the poison so applied is not readily washed off by rains. Arsenate of Lead may be applied in the same manner.

Three-lined Leaf Beetle *(Lema 3-lineata,* Oliv.).

This somewhat common potato pest is closely related to the Colorado beetle, but differs in size and color. The beetles are about one-fourth inch long, yellow in color, with three black stripes on the wings, resembling the striped cucumber beetles mentioned on p. 42. The larvæ are dirty yellow and may be recognized by the habit of covering the body with their own excrement. The eggs are orange colored, usually laid in rows along the mid-rib on the lower sides of the leaves.

When present these insects may be controlled by the remedies suggested against the Colorado beetle.

Flea Beetles *(Several Species).*

These small jumping beetles, usually black in color, riddle the leaves with small holes, but their work may be prevented by thoroughly spraying the plants with Bordeaux and Paris green mixture. The cucumber flea beetle, mentioned on p. 44, often attacks the potato plant. Poison dust sprays act both as a repellent and poison to these little creatures.

Potato Stalk Borer *(Trichobaris trinotata,* Say.).

As its name implies, the insect lives in the larval or grub stage in the stalk, boring through the heart, and when several are present, they severely weaken and generally kill the infested plants. The presence of only one or two is seldom noticed.

DESCRIPTION AND HABITS.

Adult.—The parents of the stalk borers are small, greyish weevils, about one-sixth inch in length, and having a strong, curved snout. They hibernate during winter, usually appearing early in spring to deposit eggs in the potato stalks. Otherwise they cause no apparent damage.

Larvæ.—Usually called grubs, are white or yellowish in color with brown, horny heads, and attain a length of about one-half inch. When grown they change to pupæ in cocoons in the stalk.

Life History.—There are two generations each season, the adult of the first appearing about the middle of July, while the adults of the later brood appear during August or September, and hibernate during winter. (See Fig. 32 for illustration of this insect.)

FIG. 32.—Potato Stalk Borer: *a*, beetle; (weevil); *b*, larva (borer); *c*, pupa—five times natural size; *d*, section of potato stalk opened to show larva and pupa *in situ*. (Chittenden, Bul. 33, Bur. of Ent, U. S. Dept. of Agr.)

REMEDIAL MEASURES.

It appears impossible to suggest a direct method for killing the borers in the stalks without destroying the plants, hence every effort should be directed toward keeping them from reaching the adult beetle stage, and thus prevent them from being numerous during the succeeding season. Infested plants, detected by their wilted appearance, should be pulled up and burned. After the potato crop is gathered all vines in the infested fields should be raked together, dried a few days, and then burned.

It is known that this borer breeds in the stem of the egg plant and wild plants, such as horse nettle, bull nettle, jimson weed, and many *solanaceous* plants. When these occur around infested potato fields they should be cut and burned, if possible, while the borers are in the stems, and thereby prevent the development of beetles.

White Grubs or Grubworms.

We will discuss white grubs under the head of "Potato Insects," though in reality they are often as injurious, and sometimes more so, to strawberries, corn, small grains and many tuberous rooted vegetables such as beets, turnips, etc. In fact most garden crops are injured at times by white grubs, which are more or less common in all localities. It is evident that these insects formerly subsisted on grass roots in the wild prairie lands, being native to this country, and turned their attacks to cultivated crops when deprived of their natural food by the cultivation of lands in which they lived. There are a large number of species of white grubs, some being feeders on decaying vegetable matter, manure, etc., and hence not injurious, while others subsist on the roots of growing plants.

GENERAL DESCRIPTION.

White grubs, in general, may be described as having thick bodies, and hard, horny heads, behind which are three pairs of true legs end-

ing in claws, while their abdomens are usually distinctly enlarged near the caudal ends (Fig. 33, e). They lie in a curved position, as shown in the figure. Some species get to be nearly two inches long,

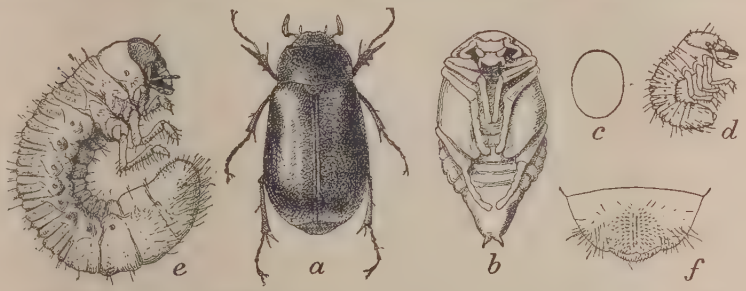

FIG. 33.—White Grub, *Lachnosterna arcuata: a*, beetle; *b*, pupa, *e*, larva—all enlarged one-fourth. (Chittenden, Bul. 19, Bur. of Ent., U. S. Dept. of Agr.)

while many are smaller. Practically all the most injurious forms belong to the genus *Lachnosterna.*

Parent Beetles.—The parents are called May or June beetles, mostly shining brown in color and quite large, being known by their habits of flying into houses attracted by the lights at night. The beetles occasionally cause much injury to pecan trees and fruit trees by eating the developing buds.

LIFE HISTORY AND HABITS.

The eggs are deposited in sod lands, weedy places, strawberry beds, especially if the latter are weedy, and young grubs feed on the roots of almost any available plants. The eggs are laid from May to July, and the grubs require from two to three years to mature, this depending on the species.

It will be seen that land once infested may remain so continuously, and when disturbed by plowing, destroying the crop, strawberries, grass or whatever was on the land, the grubs must feed on the roots of the crops following. If potatoes are planted on sod land or old strawberry beds, they are liable to be seriously damaged by these insects, and the same would be true of most other vegetables.

When mature, the grubs transform to pupæ in earthen cells, and about August or September change to the parent beetle, which may remain in the cell all winter.

REMEDIES AND PREVENTION.

Insecticides.—These are not practicable in the writer's opinion, though liberal applications of Gas Lime or kerosene emulsion have been used on lawns with some success.

Rotation.—This is another case where an ounce of prevention is

worth a pound of cure. Land known to be infested with white grubs should be sown in clover or some crop least liable to be injured by these insects, at least two years before planting in potatoes or any other tuberous vegetable. Corn land is liable to be infested, and here rotation is valuable. Sod land should never be planted to vegetables the first year after plowing. The rotation should be planned so that the land may be thoroughly plowed each fall or winter.

Fall Plowing.—This will undoubtedly kill some grubs by exposing them as prey to birds and fowls and by leaving them exposed to the winter's cold. By following fall plowing with a cross plowing or harrowing during winter when the condition of the land will permit, better results will be obtained.

Domestic Animals.—Chickens and turkeys should be encouraged to follow the plow, as they will pick up great numbers of all kinds of insects. Hogs delight to root for white grubs, and if turned into the garden and encouraged to root by scattering a little corn on the ground, they will render valuable service.

INSECTS AFFECTING THE SQUASH.

Squash Bug (*Anasa tristis*, DeG.).

Here we have another injurious sucking insect, and one that seems to inject a poison into the plant the same as as is the case with the Harlequin bug on cabbage. The name stink-bug is often applied to this insect, and to several related forms because of their disagreeable odor.

DESCRIPTION AND HABITS.

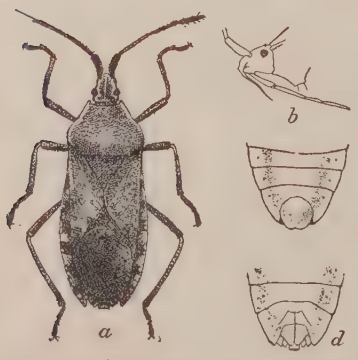

Fig. 34.—Adult Squash Bug: Twice natural size. (Chittenden, Bul. 19, Bur. of Ent., U. S. Dept. of Agr.)

Adult Bugs.—These bugs are very generally known, but may be briefly described as being a little over one-half inch long (Fig. 34), dirty blackish brown above, and mottled yellowish beneath, the head bearing a long jointed beak that lies between the legs when not in use. They are nocturnal in their habits, and hide during the day under sticks, leaves, etc.

Eggs and Nymphs.—The brownish eggs are laid in irregular rows on the leaves, and hatch into small awkward looking creatures. These young, called nymphs, generally feed for a time in groups, and increase in size by successive molts, gradually developing wings. A

dozen nymphs may seriously injure a small squash or melon plant, by the combined effect of loss of sap and poison injected.

Life History.—The adult squash bugs pass the winter in protected places, under rubbish in or about the gardens, or in fence corners, etc., appearing early in spring to deposit eggs. There may be several generations each year.

REMEDIES AND PREVENTION.

Hand Picking.—The first bugs appearing in spring may be collected by hand to prevent their depositing eggs. This practice is advisable all through the spring and summer, when plants are not otherwise protected.

Cover Protection.—Young plants may be protected by methods recommended on p. 43 under Cucumber Insects.

Trapping.—Trap plants started very early, planted indoors in strawberry baskets, if desired, and transferred to the garden, will be found very valuable. The bugs will collect on such plants and may be picked off by hand together with the egg masses. Bugs may also be trapped at all times under shingles, boards, or cabbage leaves. After feeding at night, they will hide under these traps, from which they should be collected each morning, particularly during early spring.

Spraying.—Poison sprays are obviously useless against this sucking insect, but kerosene emulsion of a strength of 10 per cent will kill the young nymphs when feeding in groups. Repellent sprays or powders (See p. 43) are of some value.

Clean Culture.—Burning all rubbish and old plants, both after the crop is gathered and during fall or winter, will do much toward preventing the adult bugs from hibernating successfully.

Squash Vine Borer *(Melittia satyriniformis,* Hbn.).

Damage from this insect is caused by the larvæ boring into the stalk, sometimes resulting in death of the infested stalk, and always causing a loss of vitality. Squash and pumpkin are the favorite food plants, but melons and cucumbers may be attacked.

DESCRIPTION.

Parent Moths.—The moths as described by Quaintance[1] have forewings opaque, shining olive brown in color, and transparent hind wings bordered by a narrow fringe of scales. The body is about three-fourths of an inch long, with a wing expanse of nearly one and

[1] Georgia Expt. Sta., Bul. 47, p. 4.

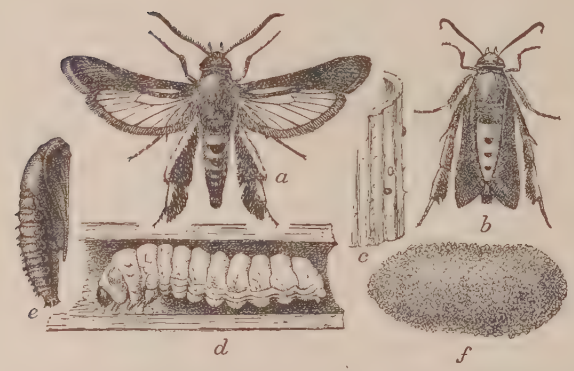

FIG. 35.—Squash-Vine Borer. *a*, male moth; *b*, female moth, wings folded; *c*, eggs on stem; *d*, larvæ; *e*, pupa; *f*, pupa cell—all one-third enlarged. (Chittenden, Cir. 38, Bur. of Ent., Dept. of Agr.)

one-fourth inches (Fig. 35, enlarged).

Larvæ and Pupæ.—The borers are about one inch long, whitish in color and grub-like in form. When grown, they leave their burrows and spin tough silken dirt covered cocoons (Fig. 36) near the base of the plant from which they emerged. In this cocoon the larva changes to a pupa and eventually to an adult moth, which escapes through the end, as illustrated in Fig. 36.

LIFE HISTORY.

Observations on the life history of this insect, made in Georgia by the writer, showed that the pupæ stage was from three to four weeks, and that adults of the first brood appeared about the last of June. The second and last generation pass the winter in cocoons, changing to moths in spring about the last of April. These dates are probably a little too early for North Carolina conditions.

FIG. 36.—Pupa and empty cocoon of squash vine borer—twice natural size. (Photo. by the author.)

TREATMENT.

The presence of borers may be detected by the accumulations of yellow excrement, cast out from the burrows about the base of the plants. Early in June this is frequently quite noticeable, and, when detected by the gardener, the borers should be carefully searched for and removed. This may be done without much additional injury to the plants, and is the only

direct remedy. The borers of the first brood should be destroyed if possible.

After the crop is gathered the vines, root and all, should be pulled and burned to destroy any borers that might be within. As some borers of the second brood are liable to form cocoons before the plants are removed, deep fall plowing is advisable. This, coupled with prompt destruction of infested plants before the borers escape, should keep the pest reduced to insignificant numbers.

Melon Borer (*Diaphania hyalinata*, Linn.).

Closely related to the borer known as the pickle worm, described on p. 44, this destructive pest causes much damage by eating off the soft rind and boring into the squash, melon, etc. It differs from the pickle worm mainly in the habit of eating the foliage more freely and is therefore more easily controlled.

DESCRIPTION.

Parent Moths.—This is quite a beautiful moth described by Quaintance[1] as having wings of pearly iridescent whiteness, with a border of brownish black. The body color is white and brown, and the abdomen terminates in a large movable brush of elongated scales. The body is about three-fourths of an inch long and wings expand about one and one-fourth of an inch (Fig. 37, enlarged).

Fig. 37.—Moth, or parent of the Melon Worm: Much enlarged. (Quaintance, Bul. 45, Ga. Expt. Sta.)

[1] Georgia Expt. Sta., Bul. 45, p. 45.

Eggs and Larvæ.—Eggs are placed singly on the lower surface of the leaves, and hatch into active caterpillars, which when grown are slightly longer than pickle worms. They are of a pale greenish yellow color and possess a black head.

LIFE HISTORY AND HABITS.

The life history of this borer is nearly the same as the pickle worm. The greatest difference in habit is that of feeding on the foliage more than the pickle worm, and this gives the gardener an opportunity to make use of poison sprays. The melon borer seems to thrive best during rainy seasons.

REMEDIES.

Spraying is quite effective against the young borers that feed on the foliage. Paris green-lime mixture, Bordeaux-Paris green mixture, or arsenate of lead may be used. The gardener should watch carefully for the first brood of melon worms and be prepared to use the arsenical sprays quickly and thoroughly. Infested fruit should be fed to hogs or otherwise destroyed.

All the preventive measures recommended on page 45 against the pickle worm should be used against the borer, except the method of using squash blooms as traps.

INSECTS AFFECTING TOMATOES.

Cutworms.—(See under Bean Insects, p. 11).

Flea Beetles.—(See under Potato Insects, p. 51).

Potato Beetles.—(See under Potato Insects, p. 49).

Tomato Fruit Worm *(Heliothis obsoleta).*

This is the same as the corn ear worm and the cotton boll worm. Under Corn Insects, p. 37, the reader will find a full description and also cultural methods of control. It is true that this is a difficult pest to fight, unless the gardener will study the habits of the worm, and learn how best to make use of corn as a trap crop, for there is no good remedy except to pick them off by hand. Corn as a trap crop, unless properly managed so as to destroy the worms that attack it, may serve only to increase the numbers of this pest.

Thorough spraying of tomato plants with Bordeaux-Paris green mixture, usually used against flea beetles and the green tomato worm, may result in poisoning some of the fruit worms. This should not be depended upon, however, for the worms eat only a small area of the surface of tomatoes.

Tomato Horn Worm *(Phlegethontius celeus,* Joh.).

This conspicuous green worm is sometimes abundant enough to cause noticeable injury and occurs also on tobacco, and on that plant it is a very serious pest. This is the larvæ of a large, narrow-winged moth, belonging to the family *Sphingidæ* or Sphinx Moths.

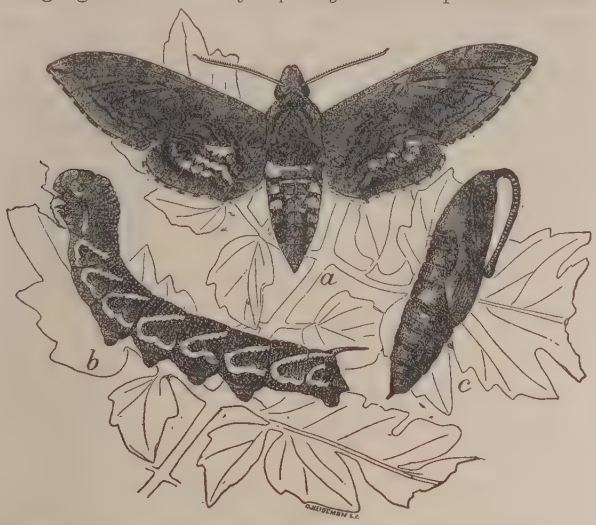

Fig. 38.—Tomata Horn Worm, *Phlegethontius celeus: a*, adult moth; *b*, full-grown larva; *c*, pupa—about two-thirds natural size. (Howard, Farmers' Bul. 120, U. S. Dept. of Agr.)

DESCRIPTION.

Larvæ.—Full grown worms are from three to four inches long, dark green in color, with oblique V-shaped white lines on each side of the body. The caudal end bears a prominent, long, sharp-curved horn that is quite characteristic. A closely related species of horn-worm, having straight white oblique lines on each side of the body is almost equally common.

Moths.—The moths have large, powerful wings, narrow compared to their length, and a robust body. The wings are brownish gray in general color with wavy markings and expand about four inches. The abdomen is marked on each side by five orange colored spots bordered with black.

REMEDIES.

Small fields of tomatoes, or especially a few garden plants, may be protected by picking the worms off by hand. Arsenical poison sprays used in connection with Bordeaux mixture is advisable, for this latter is of great value alone as a fungicide. Arsenical sprays may be used up to within ten days of the time the fruit ripens without danger of poisoning persons who eat the tomatoes.

FORMULAS AND DIRECTIONS FOR PREPARING SPRAY MIXTURE.

FOR BITING INSECTS.

Paris Green (as a liquid spray).

Paris Green	1 pound
Lime	2 pounds
Water	100 to 200 gallons
Or Bordeaux mixture	100 to 150 gallons

(See formula, next page.)

To prepare.—The combination of Bordeaux mixture and Paris green is often preferable to the simple water mixture with lime; but no matter what is used as a carrier for the poison, it should first be made into a thin paste with a small amount of water. This will prevent lumping and insure an even distribution of the poison in the mixture. When Bordeaux is used it is unnecessary to employ the extra two pounds of lime, but this should always be added to the simple water mixture. The lime unites with any free arsenic that may be present in Paris green, preventing burning of foliage that might otherwise occur.

Paris green, if absolutely pure, is entirely insoluble in water, but most commercial grades contain some water-soluble arsenic, the burning effect of which is overcome by lime. Paris green is really a very fine crystalline powder, and must therefore be held in suspension by constant agitation.

Plants with tough resistant foliage like potatoes and cabbage may be sprayed with one pound Paris green in 100 gallons of water, but tender plants such as tomatoes, beans, and celery, should be given a more diluted mixture.

Paris Green (in dry form).

Mix with from ten to fifty parts of cheap flour, land plaster, sifted air-slaked lime, ashes or fine dust and dust evenly over the plants by means of a cloth sack, pepper shaker arrangement or dusting machine.

Green Arsenoid.

This is often substituted for Paris green, and may be used in the same proportion, but should never be used as a liquid spray without the addition of lime. Green arsenoid is lighter in weight, not crystalline in form, and remains in suspension longer than Paris green, but otherwise it has no advantage unless it can be purchased at less cost.

Arsenate of Lead.

Acetate of Lead *(Sugar of Lead)*	11 ounces
Arsenate of Soda	4 ounces
Water	50 gallons

This is a formula for home-made arsenate of lead, prepared by dissolving the acetate of lead in one gallon of water, and the arsenate of soda in two quarts of water in a separate vessel. It is best to use wooden buckets. When the two solutions are poured together a fine, white precipitate is formed. This makes a stock solution ready to dilute with 50 gallons of water.

The advantages of arsenate of lead over Paris green and green arsenoid are: (1) greater adhesive quality; (2) remains in suspension with very little agitation; and (3) seldoms injures foliage. It is generally claimed that it will not burn or injure the tenderest foliage, but this is not true, although it is perfectly safe to use on most garden vegetables.

Arsenate of lead is now manufactured rather extensively and is put up and sold as a dry powder or paste. At wholesale prices the manufactured product is about as cheap as that prepared at home, and somewhat preferable, because of its always being ready to mix with water.

Bordeaux Mixture and Arsenicals.

Bordeaux mixture	50 gallons
Containing one of the following:	
Paris Green	1-3 to 1-2 pound
Arsenate of Lead	3 pounds
Green Arsenoid	1-3 to 1-2 pound

It is frequently desirable to use arsenicals in Bordeaux mixture because, in addition to killing the insects, the plants should be protected from leaf diseases. Bordeaux mixture is a great help towards keeping plants healthy. Furthermore, the poison is made to adhere longer, and is very much less liable to injure the foliage when used in this manner.

Bordeaux Mixture.

Bluestone (Copper Sulphate)	4 pounds
Lime, fresh unslaked	6 pounds
Water	50 gallons

To prepare.—Dissolve the bluestone in 25 gallons of water in one receptacle, and slake the lime in another, and dilute to 25 gallons. Do not pour the solutions directly together, but take a bucketful of each and pour these simultaneously into a barrel or spray tank. As

the solutions unite a fine blue precipitate is obtained, and the resulting mixture will not settle as rapidly as when the two solutions are mixed by pouring one directly into the other.

Many writers advocate making Bordeaux for general use with 6 pounds of bluestone and 6 pounds lime, but this is apparently stronger than is necessary, and at the present price of bluestone, is rather expensive.

Adhesive Resin Wash.

With a few plants, like cabbages and collards, which have very smooth foliage, difficulty is often experienced in making poison mixtures adhere. To overcome this difficulty, the following is suggested:

Stock Solution	Pulverized Resin	5 pounds
	Concentrated Lye	1 pound
	Fish Oil	1 pint
	Water	5 gallons

To prepare.—Place the oil and resin in one gallon of water and boil until the resin is thoroughly softened. Dissolve the lye in a separate vessel and add slowly to the resin mixture, stirring constantly until well mixed. Then add four gallons of water and continue the boiling until the resulting mixture will mix readily with cold water.

DIRECTIONS FOR USING.

Resin Mixture *(Stock Solution)*	1 gallon
Water	16 gallons
Milk of Lime (2 pounds unslaked lime)	3 gallons
Paris Green or Green Arsenoid	1-4 pound

To prepare.—Add water to the stock solution and mix thoroughly; then add the milk of lime, and then the Paris green or green arsenoid. The order of mixing should not be changed, or a heavy precipitate will form that will clog the spray pump and nozzle. The stock solution may be kept on hand, but the diluted mixture must be freshly prepared when used.

Hellebore.

Hellebore acts both as an internal and contact poison. It is used against soft-bodied caterpillars, such as cabbage worms, in liquid form, 1 ounce in 3 gallons of water; or mixed, dry, with four parts of cheap flour or road dust. It loses its strength when exposed and must be applied every two or three days as long as the worms are present. This is not very valuable for use except on vegetables that are nearly grown.

FOR SUCKING INSECTS.

Kerosene Emulsion.

Stock Solution.
- Hard Soap.....1-2 pound
- Or Soft Soap.....1 quart
- Water .....1 gallon
- Kerosene .....2 gallons

To Prepare.—Dissolve the soap in one gallon of boiling water. Remove from the fire and add two gallons of kerosene and agitate the mixture violently for fully ten minutes. As the kerosene and soap solutions combine, a smooth, creamy emulsion will result, and when properly mixed, will remain for weeks without separating. The emulsion is best prepared by using a small force pump, throwing a small stream and pumping the mixture back into itself for ten minutes. Soft water should be secured, but a little common lye may be used to "soften" water that is naturally too hard.

For convenient reference the proper amount of water used in diluting the stock solution to a certain strength is given below:

For 5 per cent emulsion dilute with 37 gallons of water.
For 10 per cent emulsion dilute with 17 gallons of water.
For 15 per cent emulsion dilute with 10 1-3 gallons of water.
For 20 per cent emulsion dilute with 7 gallons of water.

Tobacco Products (as a liquid spray).

Tobacco leaves or stems.....2 pounds
Water .....4 gallons
Boil for about 2 hours.

Tobacco water, made by the above formula, should be used at full strength. It is valuable for killing plant lice, and as a repellent against flea beetles, cucumber beetles, etc.

Tobacco Products (in dry form).

Tobacco dust is of some value as a repellent when applied liberally to the foliage of small garden plants.

Soap Solutions.

Whale oil soap, made from refuse fish oil, is a valuable contact poison for killing plant lice. The potash soaps are preferable to soda soaps. Common potash (washing or laundry) soap may be used with success at a strength of 1 pound in 3 or 4 gallons of water, and is just as effective against common garden plant lice as whale oil soap or dilute kerosene emulsion. This gives a little better result than tobacco water.

Pyrethrum.

Pyrethrum, also known as Buhach, Dalmation powder, and Persian Insect Powder, is poisonous to most insects, but harmless to higher animals. The powder gets into the breathing pores, acting by its suffocating effects, and it also contains an essential oil that kills by contact. As this oil evaporates rapidly when exposed to the air, pyrethrum must be kept in air-tight receptacles until used. Pyrethrum kept in open boxes or loose drawers is very nearly worthless.

Pyrethrum in dry form is used pure or diluted with flour, and will kill cabbage worms and most soft-bodied insects. It must be applied every two days while the insects are numerous.

Pyrethrum in solution is used by mixing 1 ounce in 2 gallons of water. In this form it will not injure the tenderest foliage.

Tobacco Fumigating Papers.

As stated on p. 41 tobacco fumigating papers have been carefully tested in Texas as a remedy for lice on cucumbers, cantaloupes, etc. The brands that have been well tested are Nico-fume Paper, To-bak-ine and Aphis Punk.

These papers are prepared so that they will burn rapidly and are generally lighted in tin cans under the fumigating frames, which are described on p. 41. Old tin cans with perforations near the bottom edge answer the purpose very well. The actual time required to kill the lice will vary, but may be easily determined by experience.

SPRAY PUMPS AND EQUIPMENT.

There are many forms of spray pumps on the market, some good, and some almost worthless for the purpose of spraying garden plants. Good, serviceable spray pumps fitted with suitable hose, extension rod, and nozzle, are quite necessary for the proper application of some materials recommended against garden insects. Readers who desire information on the subject of spray pumps and equipment should send for Bulletin 193 of the North Carolina Experiment Station, and should also write to a number of spray pump manufacturers for catalogues. Persons who have never used spray pumps will do well to investigate the merits of the different makes before making a purchase. The names of Spray Pump Concerns are listed in the Bulletin mentioned above.